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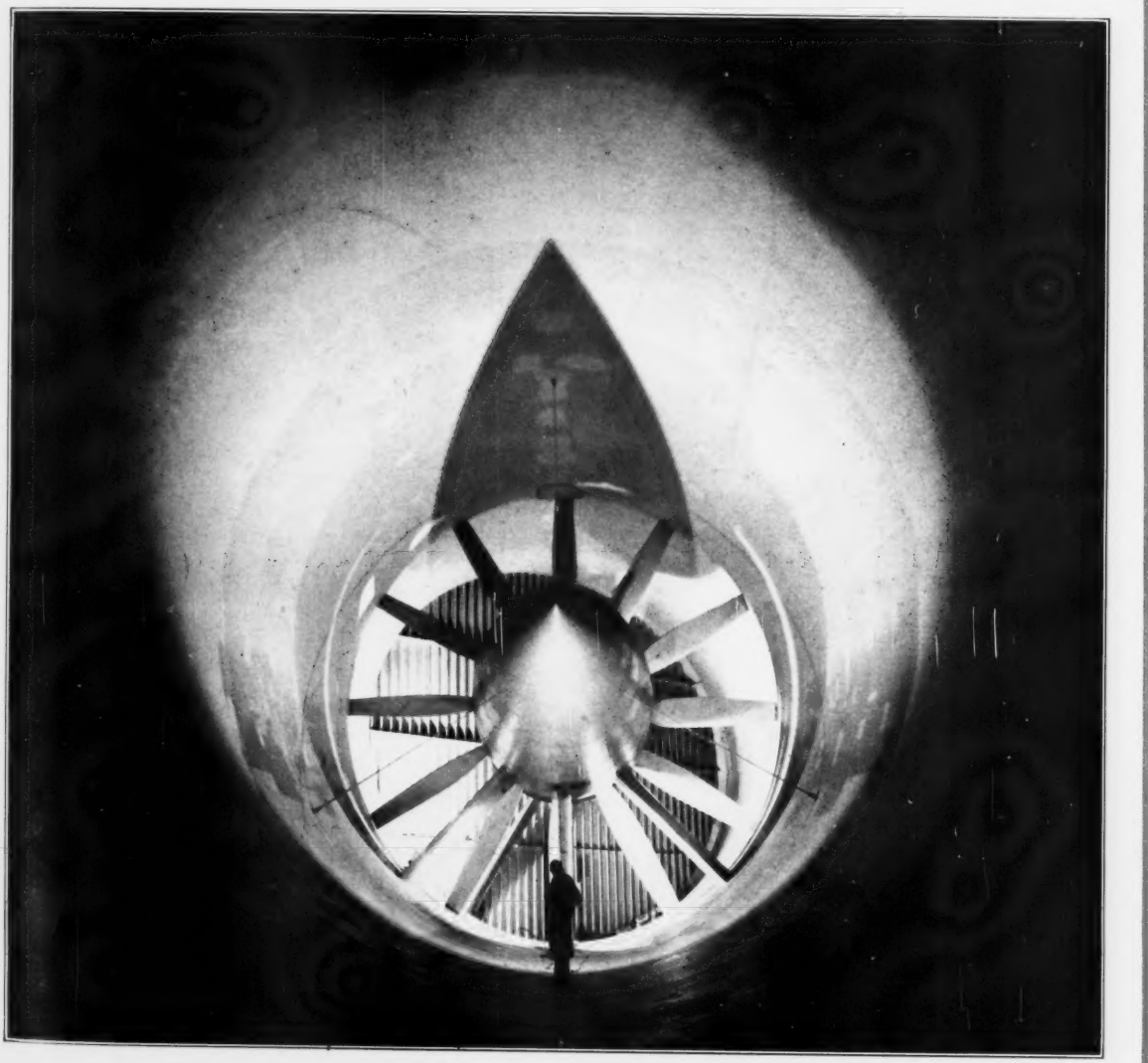

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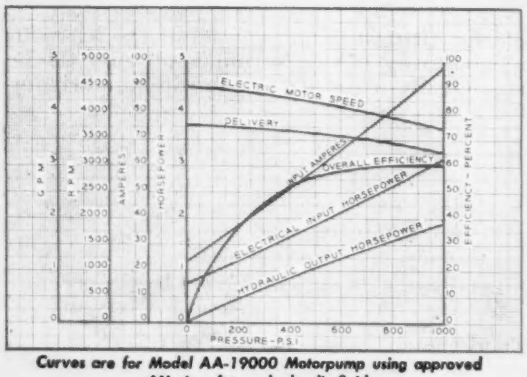

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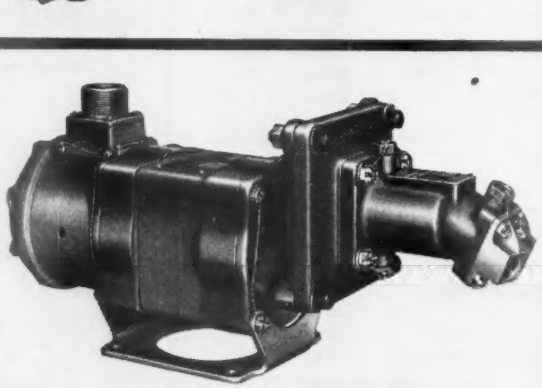

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Elimination of Direct-Reading Compass Errors by Proper Aircraft Design

JOSEPH F. MANILDI*
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SUMMARY

The earth's magnetic field is affected within the airplane by permanently magnetized iron; by soft iron, which exhibits a variable magnetism depending on its position in the earth's field; and, finally, by electrical circuits.

The sum of the distortions caused by these three sources is considerable in certain airplanes and necessitates the use of remote indicating compasses, the transmitter of which is placed in a location where the magnetic field is least disturbed.

By using certain detail design practices, it is possible to control magnetic conditions in the cockpit so as to obtain a uniform field and permit the use of a direct-reading compass with all the accuracy afforded by a remote compass and with a resultant economy in weight. This is of particular interest to the small airplane design engineer.

Design data and practice directed to reduce the magnetic distortion are outlined in the paper.

INTRODUCTION

PRESENT-DAY navigation problems aboard aircraft depend in large part on instruments, such as magnetic compasses, which obtain their directional indication from the earth's field. This fact leads to the necessity of carefully investigating and controlling the factors that tend to distort the direction of the earth's field.

One solution to the problem is obtained by placing the field sensitive element in a remote position of the aircraft, such as a wing tip, thus removing it from any disturbing electrical and magnetic effects produced by the aircraft structures and electrical system. This implies the use of a remote control system for conveying the necessary information to the instrument panel. In the event of operational failure in this type of system and in the case of small aircraft where remote indication is not feasible, a direct-reading compass must be mounted on the instrument panel. The accuracy of the direct-reading instrument depends on the proper design of the structural and electrical systems in relation to the location of the compass. It is the purpose of this paper to outline acceptable design practices and to develop design data to assist both the manufacturer and operator of an airplane in ensuring satisfactory operation of direct-reading compasses.

Presented at the Light Aircraft Meeting,' I.A.S., Detroit, October 4–5, 1945.

* Chief Research Engineer.

Distortion of the earth's field aboard an aircraft arises from two sources. First, electrical equipment produces a magnetic field that adds vectorially to the earth's field to give a resultant field at the compass location which, in general, has a direction different from the earth's field. Second, iron in the vicinity of the compass disturbs the earth's field pattern and introduces compass errors. The first type of error may result from current-carrying conductors or from pieces of equipment such as dynamotors, inverters, solenoids, and relays. The second type of error may arise from residual magnetism existing in structural items known as "hard" magnetic steels or from magnetism induced in "soft" magnetic materials by the earth's field.

Relief from the above-mentioned errors may be attained by using proper compensation methods to neutralize the offending disturbance at the compass location, by removal of the offending parts to a distance such that their effect on the compass reading is negligible, or, in the case of residual magnetism, by proper demagnetization of the offending parts.

Neutralization of the offending field can be most effectively employed in the case of most electrical circuits and equipment. Compensation for induced magnetic effects in soft iron may also be employed, although the techniques are not so straightforward and considerable experimental work is required. Removal of the offending parts to a safe distance must, of course, be made consistent with the structural requirements of the aircraft.

All design considerations presented in the following discussion are pointed toward the elimination, or the reduction to a predetermined minimum, of compass errors arising from the above-mentioned factors. Since the error will, in general, depend on the heading of the aircraft, design for removal of offending parts will be based on the case where the error is a maximum. In determining the condition of maximum error, a 5° maneuvering angle for the aircraft will also be taken into account.

CURRENT-CARRYING CONDUCTORS

The effect on compass readings of current-carrying conductors may be made negligible by removing the conductor to a sufficient distance from the compass location.

In order to calculate the error introduced by a single straight conductor, we make use of the Biot-Savart Law, referring to Fig. 1:

$$H = 0.0394\ (I/P)\ (\sin \alpha_1 + \sin \alpha_2) \qquad (1)$$

where

H = magnetic field of wire in oersteds at compass location C
I = current in conductor, amp.
P = perpendicular distance from C to wire, in.

The direction of the field is at right angles to the plane containing the compass and the wire.

If the field of the wire makes an angle β with the horizontal wire, the horizontal component is given by

$$H_H = 0.0394\ (I/P) \cos \beta\ (\sin \alpha_1 + \sin \alpha_2) \qquad (2)$$

Furthermore, if the airplane undergoes a maneuvering angle of 5°, the maximum horizontal component of the field is given by

$$H_H = 0.0394\ (I/P) \cos (\beta - 5°)\ (\sin \alpha_1 + \sin \alpha_2) \qquad (3)$$

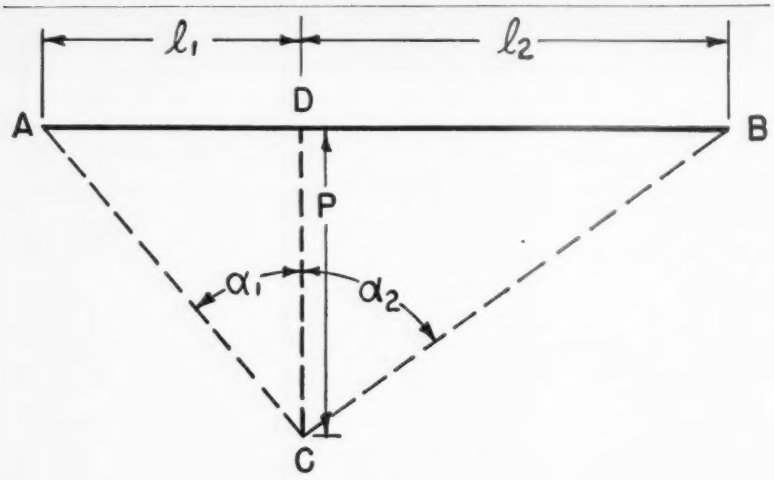

Fig. 1.

Expanding cos (β − 5°) and assuming cos 5° ≈ 1, Eq. (3) may be written

$$H_H \approx 0.0394\ (I/P)\ (\cos\beta + \sin 5^\circ \sin\beta)\ (\sin\alpha_1 + \sin\alpha_2) \qquad (4)$$

Eq. (4) states that the maximum horizontal component arising from maneuvering can be obtained by adding to the normal horizontal component the normal vertical component multiplied by the sine of 5°.

The horizontal field given by Eq. (4) will produce a maximum compass deviation, Δ, when the earth's field has a horizontal component of 0.18 oersted, given by

$$\Delta = 12.5\ (I/P)\ (\cos\beta + 0.0872 \sin\beta)\ (\sin\alpha_1 + \sin\alpha_2) \qquad (5)$$

The deviation in regions having different values for the earth's horizontal field will be inversely proportional to the value of the earth's horizontal component at the location.

Eq. (5) may be written, referring to Fig. 1, as follows

$$\Delta = \frac{12.5I}{P}\left(\frac{l_1}{\sqrt{l_1^2 + P^2}} + \frac{l_2}{\sqrt{l_2^2 + P^2}}\right)(\cos\beta + 0.0872 \sin\beta) \qquad (6)$$

By using Eq. (6), the minimum allowable distance, P, may be determined when the current, I, the permissible deviation, Δ, and the lengths l_1 and l_2 are known. The equation must be solved by trial and error, since it is not possible to solve for P explicitly.

In the case of circuits containing more than one wire and circuits made up of several segments of straight wires, the contribution of each segment may be calculated according to Eq. (1) and the resultant field may be obtained by vector addition of the component fields. The maximum horizontal component may then be obtained by calculating the horizontal component in level flight and adding the vertical component multiplied by the sine of 5°. The expected deviation may then be calculated, and, if it is too large, the circuit must be rearranged.

In cases involving wire segments that are not straight, experimental mock-ups and a magnetometer must be used to calculate the disturbing field.

Compensation of Offending Fields

In cases where parallel returns are impractical and allowable distances cannot be adhered to, it becomes necessary to neutralize the offending field.

In practice it is desirable to neutralize completely the field of the wire at the compass location. Neutralization of the horizontal component only is no easier to attain and will not compensate completely when the ship is not in horizontal flight.

Neutralization may be effected by using any one of three principal methods:

(1) Compensating coils shunted from the main circuit branch and located near the compass.

(2) Single or multiple compensating loops in which the total circuit current flows.

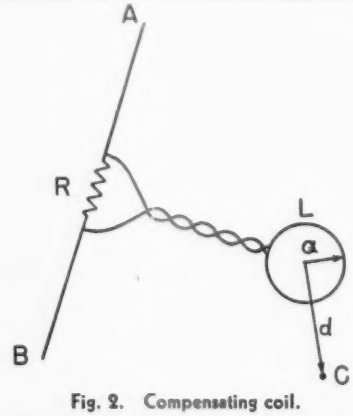

Fig. 2. Compensating coil.

(3) Split wire neutralization, in which branches of the circuit are located on opposite sides of the compass.

The last case has been treated in previous literature[1] and will not be discussed.

Neutralization by using a shunted coil is illustrated in Fig. 2. The wire AB is a part of the circuit whose field is to be neutralized. A resistance R is placed in series with this circuit. A coil L, having a radius, a, is placed with its center a distance, d, from the compass, C. The coil is oriented so that the point C lies in the plane of the coil and the axis of the coil is parallel to the offending field at C. The ends of the coil are connected by twisted leads to the ends of the resistor R.

In this position the field of the coil is parallel to the offending field, and, by proper adjustment of the distances d and a and the resistor R, the two fields may be made to cancel. In design practice it is best to select reasonable values of a and d, then adjust R and the size of wire of the coil to accomplish neutralization.

The field, H_c, due to a coil of wire at a point in the plane of the coil, such as C, Fig. 2, is given by:[2]

$$H_c = \frac{NI_c}{1.27D(a + d)} \text{ oersted} \qquad (7)$$

where

N = number of turns in coil
I_c = current through the coil, amp.
a = radius of coil, in.
d = distance from center of coil to point C, in.
D = constant,* depending on ratio d/a, and given in Fig. 3

If the offending field per unit current in wire AB is h($h = H/I$), the field due to a current I will be hI. If this be equated to the compensating field given by Eq. (7), solving for the ampere turns of the coil gives

$$NI_c + 1.27hID(a + d) \qquad (8)$$

Neglecting the resistance of the coil leads, the ampere turns of Eq. (8) may be expressed in terms of the resistance R and the resistance of the wire used to wind the coil. The voltage across the coil is IR; hence, the current, I_c, through the coil is IR/R_c, where R_c = resistance of the coil. If the coil wire has a resistance, ρ, per in., then $R_c = 2\pi a\rho N$ and the current in the coil is:

$$I_c = IR/2\pi a\rho N$$

or

$$NI_c = IR/2\pi a\rho \qquad (9)$$

Since wire resistance is usually given in tables in ohms per 1,000 ft., r, Eq. (9) may be written

* This constant is given by

$$D = \left[K + \frac{[1 + (d/a)]}{[1 - (d/a)]}E\right]$$

where K and E are complete elliptic integrals of the first and second kinds, respectively, and of modulus:

$$k = 2\sqrt{d/a}/[1 + (d/a)]$$

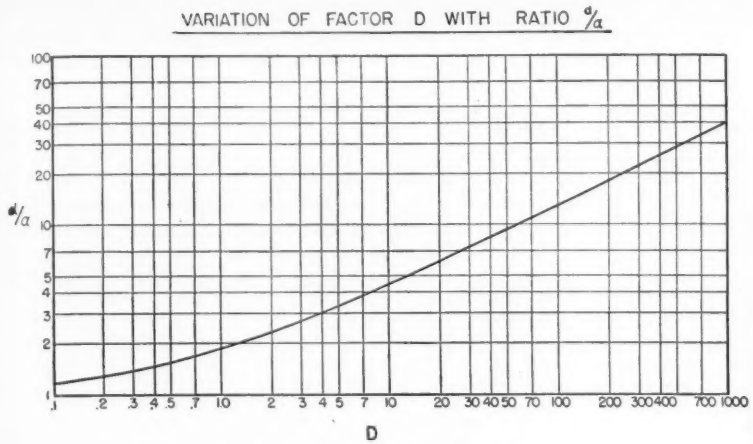

Fig. 3. Variation of factor *D* with *d*/*a*.

$$NI = 6{,}000IR/\pi ar \qquad (10)$$

Equating Eqs. (8) and (10) and solving for (R/r) yields

$$R/r = 66.5 \times 10^{-8}haD(a + d) \qquad (11)$$

Eq. (11) gives the condition that must be satisfied by the resistor R and the resistance per 1,000 ft., r, of the wire with which the coil must be wound if the resistance of the coil leads are neglected in comparison to the resistance of the coil. It will be indicated later how the lead resistance may be taken into account if it is not negligible. It is to be noted that the number of turns in the coil is immaterial. For instance, increasing the number of turns by a factor of two increases the resistance by a factor of two, the current is cut down to half value, and the field remains unchanged.

The design procedure may now be outlined:

(a) Choose a reasonable value of a and d.

(b) Calculate h, the offending field due to unit current.

(c) Select a wire size that seems suitable for winding the coil.

(d) Calculate R from Eq. (11), using Fig. 3 to obtain D.

(e) If the value for R obtained in (d) is too large for insertion in series with the line or too small to be feasibly standardized, choose a larger or smaller size wire and repeat calculations until satisfactory values are obtained. If the initial answer is far out of line of usable values, it may be necessary to select new values of a and d.

(f) Wind enough turns of the chosen wire to make the lead resistance small compared to coil resistance (at least one-tenth of coil resistance).

(g) If step (f) is not feasible, increase the chosen value of R by a factor equal to the ratio of the coil plus the lead resistance to the coil resistance.

Neutralization of an offending field by means of a compensating loop is illustrated in Fig. 4. The wire AB, without the loop, is part of the circuit whose effect at the compass location K it is desired to neutralize. The single loop CDEF, whose dimensions are shown, accomplishes the neutralization. The plane of the loop contains the point K and is at right angles to the offending field at K. The field due to the loop, for 1-amp. current in the circuit, is given by:

$$\left(\frac{H}{I}\right)_L = \left.\begin{aligned} &\frac{0.0394}{r-b}\left(\frac{d+a}{\sqrt{(r-b)^2+(a+d)^2}} + \frac{d-a}{\sqrt{(r-b)^2+(a-d)^2}}\right) - \\ &\frac{0.0394}{d-a}\left(\frac{r}{\sqrt{r^2+(d-a)^2}} - \frac{r-b}{\sqrt{(r-b)^2+(d-a)^2}}\right) - \\ &\frac{0.0394}{r}\left(\frac{d-a}{\sqrt{r^2+(a-d)^2}} + \frac{d+a}{\sqrt{r^2+(a+d)^2}}\right) - \\ &\frac{0.0394}{d+a}\left(\frac{r}{\sqrt{r^2+(d+a)^2}} - \frac{r-b}{\sqrt{(r-b)^2+(a+d)^2}}\right) \text{ oersted} \end{aligned}\right\} \qquad (12)$$

where the distances are measured in inches.

This expression also holds if the compass is located at K'—i.e., for $d < a$.

If the offending field per unit current, (H/I), is known, the field given by Eq. (12), which is opposite in direction, must be made equal to (H/I).

The three adjustable quantities in Eq. (12) are a, d, and b. Two of these quantities, a and d preferably, should be chosen arbitrarily to suit conditions of space and then a value of b found which will satisfy Eq. (12). Since it is not possible to solve explicitly for b, the proper value must be obtained by a trial-and-error method.

Solving Eq. (12) by trial and error will be lengthy and cumbersome in general. A solution to the problem may be obtained much more simply by use of Fig. 5. Fig. 5 gives the compass deflection per unit current in terms of the distance P and the lengths l_1 and l_2 of Fig. 1. Using $l = l_1$ and $l = l_2$ and adding the deviations obtained with each of these values will give the deviation per unit current for a segment such as AB of Fig. 1. From this chart the total field per unit current may be obtained for each of the segments CD, DE, EF, and FC of the loop, as well as the offending field due to the wire AB. The total field due to the loop may then be obtained by adding these separate fields algebraically. The dimensions of the loop can be adjusted by trial and error until the loop field is equal to the disturbing field at the compass location. Here again, it is best to choose arbitrarily two of the values, say a and d, and then select b to satisfy conditions.

The proper sign must be attached to the fields from each segment, since the fields from some of the segments are in the same direction as the offending field, while from other segments they are in the opposite direction. For example, in Fig. 4 the fields from segments CD, EF, and FC are in the same direction as the offending field, while the field from the segment DE is opposite to the offending field at the compass location K. If the compass were located at K', both segments DE and EF would have fields opposite to the offending field.

In cases where it is not practical to put the loop in such a manner that the compass lies in the same plane, the designer must follow a procedure similar to the one outlined above, taking into consideration the orientation of the segments in relation to the compass and the vector nature of the magnetic field.

The above analysis presumes that no magnetic material is in the vicinity to disturb the calculated fields. If such factors are present or may be present, it is desirable to make preliminary calculations as outlined above and then construct a mock-up and make fine adjustments with the aid of a magnetometer.

In general, shunt coils are more versatile and may be more easily designed and placed in the airplane than the single large loops. The particular method to be used must be dictated by the particular situation.

Experimental Methods

In investigating electrical wiring systems that cannot be analyzed simply, it becomes necessary to use a magnetometer or similar device to determine safe distances for compass locations. Also, in designing compensating loops or coils, it may not be possible to calculate theoretically the magnitude and direction of the offending field at the

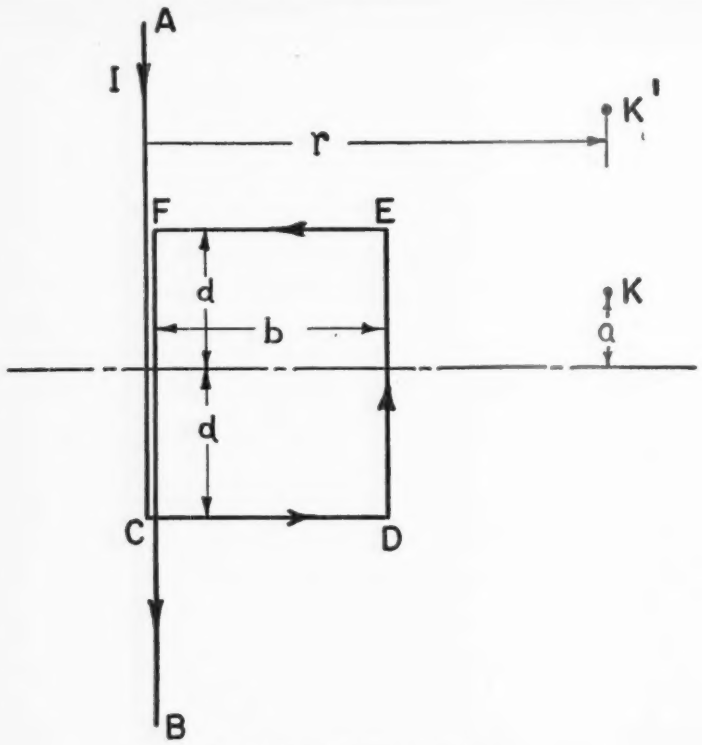

Fig. 4. Single compensating loop.

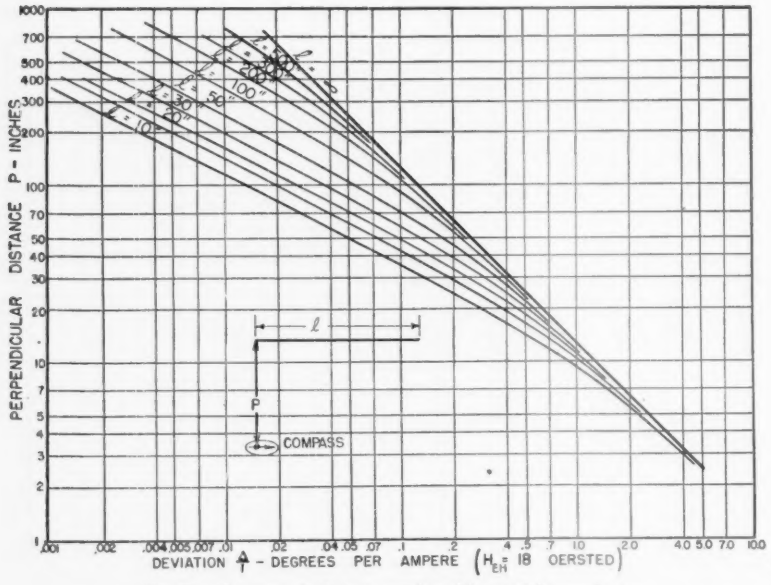

Fig. 5. Compass deviations produced by straight conductors.

compass location. The magnetometer may be used for finding the magnitude and direction.

Both of the cases mentioned above can be treated by finding the three rectangular components of the disturbing field at the compass location.

With the aid of Fig. 6, the procedure for finding the three components will be outlined. In Fig. 6 H_{EH} is the earth's horizontal field and H_{EV} is the earth's vertical field. We will assume no permanent magnetism or induced magnetism effects to be present in the electrical mock-up.

The magnetometer pickup should be placed at O, the proposed compass location. The pickup should be leveled by means of the leveling screws and then oriented in an east-west direction. The latter orientation will be indicated by a

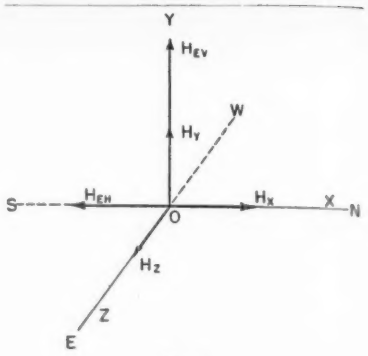

Fig. 6.

zero reading on the indicator. All electrical currents should be off during the adjustment.

The mock-up should then be placed with the desired orientation relative to the compass location. (The orientation with respect to the cardinal points is unimportant. The vertical axes of the mock-up should be vertical, however.)

The desired currents should then be made to flow in the mock-up. The fields H_{x_1}, H_{y_1} and H_{z_1} due to the currents, will appear. The magnetometer will read the value of the component H_{z_1} which is the east-west component for this orientation.

The entire mock-up should be rotated rigidly about the Y axis through 90°. The original field H_x now lies in the east-west direction and can be read from the magnetometer.

The mock-up assembly should then be rotated rigidly 90° about the X axis. The original field H_y will now be in the east-west direction and can be read.

The direction of rotation or the order of rotation about the X and Y axes is immaterial; however, for designing compensating systems, care should be taken in interpreting the magnetometer readings (scale reads plus and minus) so that the proper direction for the three components may be obtained.

Having obtained the above values the horizontal component of the field from the mock-up (taking into account a 5° maneuvering angle) will be given by:

$$H_H = \sqrt{H_z^2 + H_x^2} + H_y \sin 5° \quad (13)$$

The maximum deviation in degrees will then be given by:

$$\Delta = 57.3(H_H/H_{EH}) \quad (14)$$

If data are required for the design of a compensating coil, the magnitude and direction of the total field, H, which is to be neutralized, may be obtained from the relations:

$$\left.\begin{aligned} H &= \sqrt{H_x^2 + H_y^2 + H_z^2} \\ \tan\alpha &= H_x/H \\ \tan\gamma &= H_z/H \end{aligned}\right\} \quad (15)$$

where α and γ are the angles the field makes with the X and Z axes, respectively.

Electrical Equipment

Compass deviations caused by electrical equipment mounted in the airplane must be analyzed mainly from a standpoint of experimental data obtained from the pieces of equipment individually. Because of the wide variety of electrical equipment used and the dissimilarity in design of pieces whose operational functions are the same, it is difficult to establish accurate design data for allowable distances covering large classes of equipment.

It is possible, however, to examine representative pieces of equipment and to establish roughly the field patterns and allowable distances for such pieces. Figures so established must necessarily be conservative, and it should be understood that pieces of equipment falling in a particular class may in many cases be placed closer than indicated, depending on the specific design and the orientation of the piece in relation to the compass.

Modification factors for orientation may be calculated in cases involving simple equipment, such as solenoids and relays. In cases involving more complex types of equipment, such as transmitter and receiver assemblies, these modification factors must be obtained experimentally, and they will vary from one type of design to another.

Compass disturbances arising from solenoids and relays are almost entirely electromagnetic in nature, and the field pattern from such pieces is comparatively simple.

Compass disturbances arising from motors, inverters, dynamotors, amplidynes, and radios, on the other hand, cannot be analyzed so simply. The disturbing field usually exhibits the combined effects of residual magnetism, induced magnetism, and electromagnetic effects. The first two effects arise from the action of the earth's field and the field of the current in the equipment on the iron present. The electromagnetic effect, of course, arises from the current-carrying conductors in the piece of equipment. The resulting field is, in general, of a complex nature and will vary considerably between pieces having similar functional tasks but varying in design.

The data presented in this section consequently must be interpreted with care by the designer. If the piece of equipment under consideration is to be placed at a distance that falls outside the minimum distance established for that class of equipment, it will, in general, be safe, unless the piece involves some radical difference in design from most pieces of equipment in that class. On the other hand, if it is desired to place the piece closer than the allowable distance specified, it may be safely possible to do so, providing the proper orientation is chosen. This orientation may be calculated in the simpler cases or experimentally determined for more complex types of equipment. The detailed procedure for such calculations and experimental measurements will be given below.

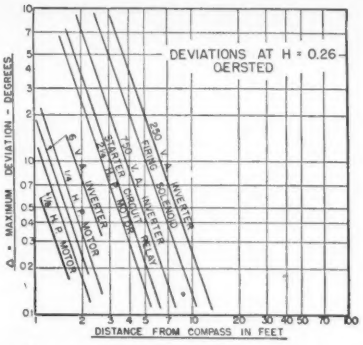

Fig. 7. Maximum compass deviations produced by various types of electrical equipment.

Design Data

Data obtained on representative types of electrical equipment are presented in Fig. 7. These data represent the worst possible orientation of the piece of equipment relative to the compass location in the same horizontal plane as the compass.

In the case of inverters and motors, the worst orientation is with the mechanical axis at right angles to the line joining the piece of equipment and the compass. (The angle between these lines shall be denoted by θ.) This is due to the fact that the field poles from which the major disturbance occurs have an electrical axis at right angles to the mechanical axis.

For relays and solenoids the worst orientation is with the axis of the coil passing through the compass location.

The curves of Fig. 7 show clearly that the fields from these units follow closely an inverse cube law with respect to distance. The slope of all the lines shown is close to 3.

In the case of solenoids, relays, and any type of electrical equipment whose field is similar to a single coil, the deviation of any orientation can be obtained by using the curves of Fig. 7. The procedure may be outlined with the aid of Fig. 8.

Let C be the compass location and P be the point of location of the piece of equipment. The XY plane is the vertical plane containing the points C and P. The X axis is horizontal and the Y axis is vertical. The Z axis is at right angles, forming a rectangular coordinate system. The line CP is the distance r, making an angle ϕ with the horizontal. The *electrical* axis of the solenoid is along the line PQ. The line PQ makes an angle a, b, c, respectively, with the X, Y, and Z axis.

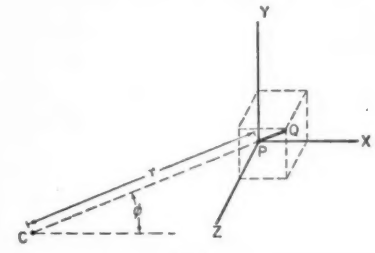

Fig. 8.

The procedure for obtaining the maximum deviation, with respect to all headings, of the piece of equipment, is as follows:

(1) Measure the distance r and the angles ϕ, a, b, and c.

(2) Obtain from Fig. 7 the maximum deviation corresponding to the distance r for the piece of equipment in question.

(3) Calculate:

$$\left.\begin{aligned}\Delta_1 &= \Delta \cos a\\ \Delta_2 &= \Delta \cos b\\ \Delta_3 &= \Delta \cos c\end{aligned}\right\} \qquad (16)$$

(4) Calculate:

$$\Delta_x = \Delta_1\left(\frac{1+3\cos 2\phi}{4}\right) + \Delta_2\left(\frac{3\sin 2\phi}{4}\right) \qquad (17)$$

$$\Delta_z = \Delta_3/2$$

(5) The deviation corresponding to the given orientation, which shall be called Δ', is then given by:

$$\Delta' = \sqrt{\Delta_x^2 + \Delta_z^2} \qquad (18)$$

Care should be taken to attach the proper sign to the cosines of the angles in Eq. (16)—i.e., cos a is negative in the second and third quadrant and positive in the first and fourth quadrant. Derivations of the above equations are given in the Appendix.

In the above manner, chosen locations may be checked to ascertain whether or not an undesirable compass deviation will be produced.

It should be noted that the deviations given in Fig. 7 are at a location where $H = 0.26$ oersted. Deviations at other values of H are inversely proportional to H, and the data should be modified accordingly.

For electrical equipment whose magnetic field is not likened to a simple coil, experimental mock-ups, using a magnetometer or compass, are advisable if it is desired to place the pieces closer than the distances given by Fig. 7.

Ferromagnetic Material

The study of compass deviations arising from magnetic material in the vicinity of the compass separates itself logically into two categories: first, the study of residual magnetism effects; and, second, the study of induced magnetism effects.

Residual or permanent magnetism existing in a magnetic member may vary widely, depending on the magnetic history of the piece. Because of the extensive use of magnetic testing, almost all structural items have been subjected to strong magnetization during the course of their fabrication and assembly. The items in question retain more or less of the magnetism induced in them, depending on their characteristics.

Steps may be taken, however, to reduce the residual magnetism in all parts to a point where the compass deviations

produced are negligible. The methods are practical from an industrial point of view and have been used to some extent in present aircraft factories.

After demagnetization, some magnetic materials may re-acquire permanent magnetism because of the action of the earth's field and vibrations that the piece undergoes in the operating aircraft. The amount of "subpermanent" magnetism which may be acquired in this manner depends on the magnetic characteristics of the material in question. This investigation has determined that the characteristics of some materials to acquire "subpermanent" magnetism is not a serious one and in most cases can be neglected entirely. In cases where it cannot be neglected in considering compass deviations, proper allowances can be made.

The effects of induced magnetism are of a more serious nature than residual magnetism. While the effects of residual magnetism can be made negligible by proper demagnetization, nothing can be done directly about the magnetism induced in a magnetic structure by action of the earth's field.

Two methods of approach may be followed in making compass deviations, arising from induced magnetism, fall within allowable limits. The first method consists of setting up experimentally determined design procedures that will permit designers to place materials susceptible to induced magnetism sufficiently far away from the compass so that deviations produced are negligible. The second method consists of placing, near the compass, small pieces of magnetic material of such a size, shape, and orientation that the effects of induced magnetism in other structures will be neutralized. The first method is easier and more desirable. However, in cases where it is not possible to remove the pieces to the required distance, the second method must be resorted to.

A detailed presentation of design techniques and data pointed toward reduction of compass errors due to ferromagnetic effects is too lengthy to be presented here. It should be emphasized, however, that proper practice and design relating to reduction of compass errors arising from ferromagnetic effects is fully as important as proper practice relating to reduction of errors from electrical equipment.

Conclusion

At the present state of development of the subject, it is possible to state that direct-reading compasses may be incorporated safely in any type of aircraft if proper measures are taken to ensure their accuracy.

The necessary measures are fewer and simpler in the case of a small peacetime aircraft than in the case of larger military aircraft with their abundance of necessary associated equipment. The rigid requirements placed on compasses in the war, however, have been responsible for the close study of the problem of reducing compass errors, and the accumulated data resulting from these requirements will be of great use to designers of peacetime aircraft.

References

[1] Beck, H. R., and Burt, R. C., *Electric Circuits and the Magnetic Compass*, Transactions A.I.E.E., Vol. 63, No. 1, pp. 24–27, January, 1944.

[2] Smythe, W. R., *Static and Dynamic Electricity*, 1st Ed., pp. 266 and 267; McGraw-Hill Book Company, Inc., New York, 1939.

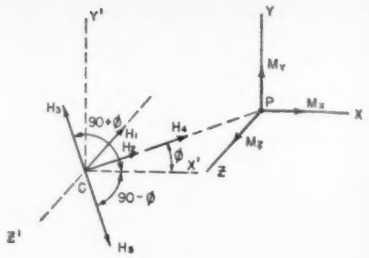

Fig. 9.

Appendix

Referring to Fig. 9, points P and C lie in XY plane

$$r = \text{distance } \overline{PC}$$

A coil or magnet of strength M will produce a field H at a distance r given by

$$\left.\begin{aligned} H_r &= (2M/r^3)\cos\theta \\ H_\theta &= (M/r^3)\sin\theta \end{aligned}\right\} \quad \text{(I.1)}$$

where H_r and H_θ are components along r and perpendicular to r, and where θ is the angle between the axis of the magnet and the line r.

Breaking the magnet into components M_x, M_y, and M_z, we have the field H_r along the Z axis due to M_z and given by

$$H_1 = H_z = M_z/r^3 \quad \text{(I.2)}$$

Because of the component M_x, we have the fields H_2 and H_3, lying on the XY plane, and given by

$$\left.\begin{aligned} H_2 &= (2M_x/r^3)\cos\phi \\ H_3 &= (M_x/r^3)\sin\phi \end{aligned}\right\} \quad \text{(I.3)}$$

Because of the component M_y, we have the fields H_4 and H_5, lying in the XY plane, and given by

$$\left.\begin{aligned} H_4 &= (2M_y/r^3)\sin\phi \\ H_5 &= (M_y/r^3)\cos\phi \end{aligned}\right\} \quad \text{(I.4)}$$

The field in the Z direction is given by Eq. (I.2) and the field in the X direction, obtained by taking the components of H_2, H_3, H_4, and H_5 in the X direction, is given by

$$\left.\begin{aligned} H_x = \left(\frac{2M_x}{r^3}\cos\phi + \frac{2M_y}{r^3}\sin\phi\right)\cos\phi + \left(\frac{M_y}{r^3}\cos\phi - \frac{M_x}{r^3}\sin\phi\right)\sin\phi = \\ \frac{1}{r^3}\left[M_x(2\cos^2\phi - \sin^2\phi) + 3M_y\cos\phi\sin\phi\right] = \\ \frac{1}{r^3}\left[M_x\left(\frac{1+3\cos 2\phi}{2}\right) + \frac{3}{2}M_y\sin 2\phi\right] \end{aligned}\right\} \quad \text{(I.5)}$$

When $\phi = 0$, the maximum deviation, given by the curves in Fig. 7 is

$$\Delta = KH = K(2M/r^3)$$

or

$$M = \Delta r^3/2K$$

hence,

$$\left.\begin{aligned} M_x &= \frac{\Delta r^3\cos a}{2K} = \frac{\Delta_1 r^3}{2K} \\ M_y &= \frac{\Delta r^3\cos b}{2K} = \frac{\Delta_2 r^3}{2K} \\ M_z &= \frac{\Delta r^3\cos c}{2K} = \frac{\Delta_3 r^3}{2K} \end{aligned}\right\} \quad \text{(I.6)}$$

Where a, b, and c are the angles that M makes with the X, Y, and Z axes, respectively.

Substituting Eq. (I.6) in Eqs. (I.5) and (I.2) and noting that $\Delta_x = KH_x$ and $\Delta_z = KH_z$, we obtain

$$\left.\begin{aligned} \Delta_x &= \Delta_1\left(\frac{1+3\cos 2\phi}{4}\right) + \Delta_z\left(\frac{3}{4}\sin 2\phi\right) \\ \Delta_z &= \Delta_3/2 \end{aligned}\right\} \quad \text{(I.7)}$$

The deviations (I.7) are produced by fields H_x and H_z, and, hence, the total deviation is the vector sum or

$$\Delta' = \sqrt{\Delta_x^2 + \Delta_z^2} \quad \text{(I.8)}$$

Probable Materials of Construction for the Postreconversion Light Airplane

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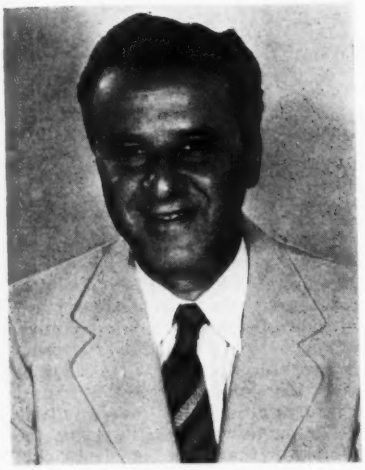

Introduction

THE PREPARATION OF THIS PAPER was undertaken with the primary thought that an investigation of the materials of which postwar private airplanes are to be built would be of value. Immediately following the war there was a great deal of talk about the private airplane of the future. A number of interesting designs have been proposed but there seems to have been no definite statement made of the materials to be used.

In the majority of cases, private airplanes going into production are of the same materials as the prewar versions, so that the immediate postwar airplanes will be built largely of traditional materials. Most of them will be of similar design to the prewar versions except for slightly increased horsepower. Prices will be substantially increased. It is obvious that once competition asserts itself there will be a necessity for improved materials and types of fabrication and it is primarily with these that this paper will be concerned.

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Materials for Construction

Wood

(a) *Usage.* The traditional usage of wood in aircraft is well known and need not be dwelt upon. All aircraft parts except machine surfaces can be made of wood. Where manufacturing facilities do not possess tooling for other materials, wood is the most economical material to fabricate since it requires only hand tools. In these cases, therefore, the only reasons for not using wood are considerations of performance and durability in competition with other materials.

Light aircraft show a strong tendency to maintain wooden wing strength members; that is, it seems to be traditional to maintain wood wing beams in the majority of these aircraft. The reasons for this decision do not bear analysis and it will be shown that metal beams are both cheaper and more durable.

Singularly enough, the use of wooden fuselage structures in the vicinity of the personnel was one of the first to be condemned, largely because of the splinter danger to the crew. Yet wooden and composition fuselages are still held to be desirable by sponsors of many of the newer processes.

(b) *Compounding by Bonding.* Most wooden fuselages now proposed are of the laminated type of monocoque structure, usually made up of two layers of veneer running at 90° to each other and fastened together with a plastic-type binder. One of the commonest of these processes, which has had fairly wide application, consists of using the plastic binder over a rigid form of some type with a method of applying pressure to the layers, generally with application of heat in an autoclave. Such a structure has also been used for wings and may be used for other large sections of aircraft. It has a fairly good strength-weight ratio although not so good as in the metals. It will be shown that the maintenance considerations are not nearly so good as those for metal.

(c) *Plasticizing.* There have been various combinations of plasticizing—by the addition of plastic materials by means of heat and pressure, forming such materials as compreg and its derivatives. These materials are of fairly high strength and density and may be used for many of the more highly stressed portions of the wooden airplane. However, as will be shown later, they have the inherent fault of water-absorption distortions. It must be remembered that the basic constituent is wood with various degrees of impregnation and that this wood is still subject to distortion due to water absorption that tends to allow it to expand toward its original proportions.

TABLE 1
Comparative Weights of Various Woods, Plastic, and 24ST[1]

	Properties and Relative Weight Ratios								
		Tension		Compression		Shear		Bending		
Material	Specific gravity	Ultimate stress, lbs. per sq.in.	Weight ratio	Ultimate stress, lbs. per sq.in.	Weight ratio	Ultimate stress, lbs. per sq.in.	Weight ratio	Ultimate stress, lbs. per sq.in.	Weight ratio	Modulus of elasticity, 1,000 lbs. per sq.in.
24ST	2.8	62,000	1	62,000	1	37,000	1	62,000	1	10,300
Spruce	0.4	10,000	0.89	5,500	1.61	1,000	5.29	7,500	0.58	1,300
Spruce plywood*	0.43	5,600	1.70	4,400	2.16	2,370	2.40	....	..	1,390
Birch plywood*	0.67	13,200	1.13	5,000	2.97	2,600	3.41	....	..	2,259
Compressed plywood is made of 1/48-in. Alternate Cross Birch Veneers, bonded with Tego Resin Film	0.77	12,550	1.36	8,580	1.99	7,240	1.41	....	..	2,259†
	1.05	19,160	1.21	11,720	1.98	11,540	1.20	....	..	....
	1.30	25,740	1.12	14,220	2.02	16,180	1.06	....	..	....
Molded phenolic cotton fiber filler	1.33	25,000	1.18	....	..	....	..	29,500	0.78	2,380

* All mechanical characteristics for three-ply panels refer to the loads parallel to the grain of the faces. Shearing characteristics refer to the load at 45°.

† Value not certain.

TABLE 2[2]

Material	Where Used	Flex. Strength	Yield Bending Tensile Strength	Tensile Ultimate	Elongated at Failure	*E*
Cellulose acetate	Lumarith Windshield	10,000 to 18,000	6,000 to 9,000	10,000	2.5	400,000
Methyl methacrylate	Lucite Enclosures Plexiglas	11,000 to 15,000 fe	7,200 to 30,000	6,000 to 10,000	0.2 to 0.6	2 to 5 × 10^5
Cast phenolic resins	Bakelite General Cast parts	2,000 to 15,000	.....	2,000 to 10,500	.....	2 to 40 × 10^5
Phenolic molding compound	Bakelite Durite Fabric filled Mineral filled	7,900 to 32,000	3,500 to 9,000	3,500 to 9,000	.....	.....
Laminated phenolics	Paper base Fabric filled Structural members Tubes, etc.	Paper base to 32,000 Fabric base to 36,000	.....	5,000 to 12,500	.....	2 to 40 × 10^5

Plastic

(a) *Materials.* Table 2 shows the properties of plastic materials that are being used for aircraft work. As a further example of what may be done with specialized compositions using plastic bases, a rather complete discussion of a molded fiber glass fuselage is given in reference 3. The fuselage referred to was built and tested by the Army Air Forces at Wright Field.

Cotton, linen, rayon, silk, and glass fibers have been used in plastic laminates. The glass fibers have a greater strength-weight ratio than any of the other fibers and they can be easily controlled to make a uniform laminate.

Table 3 (from reference 3) shows that the balsa wood–glass fiber plastic sandwich has a good strength-weight ratio.

(b) *Forming and Fabricating Methods.* The use of plastic resin adhesives is now fairly general. These adhesives may be classified as follows:

(1) Hot-setting adhesives—which require heat to cure and, generally, pressure in addition to heat.

(2) Room-setting adhesives—which generally require catalysts for activation.

Glass fabrics are used laminated[3] with a copolymer resin which is cured in the presence of air with the addition of heat. As with most of the modern thermosetting resins, high pressure is not necessary. Therefore, the new contact pressure resins may be bonded with glass fiber developing an extremely high strength structure without the use of high pressures, the only pressure necessary being that required to hold the parts together.

The laminated resins are applied to the glass cloth by means of squeegees. After being impregnated with a resin, each layer of cloth is transferred to the male mandrel in such a way that the direction of the fibers in successive layers is alternately 12° to the right and left of the axis of the fuselage.

(c) *Water Absorption an Inherent Fault.* One of the greatest difficulties with plastics as an engineering material is the possibility of a change in their shape and dimensions as a result of water absorption. It may be stated that any absorption of water by plastic material will change its overall dimensions. Where plastics are used as an electric insulation or in applications where the main dimension may be held by metal portions, plastics undergo little trouble from this source. However, in many cases where plastics have been used as primary structural material water absorption has resulted in considerable warping. In time this warping causes the misfit of parts and other misalignments. In order for any plastic to be accepted as an approved structural material it must have extremely low water absorption, possibly lower than any now available.

(d) *Advantages If Structurally Preformed.* Plastics provide some advantages that have not been utilized but which show great engineering promise. Because of the ease of fabrication in large quantities by molding, it would be entirely feasible to build large numbers of small units structurally reinforced. For example, a wing covering of the general shape of a waffle could be readily made in large numbers of units. It will be shown that these would be more desirable from the standpoint of strength-weight ratio as wing structure, and the cost should not be prohibitive.

(e) *Necessity for Certain Improvements to Be Acceptable.* It may be stated, therefore, that plastics, if used for structural materials, would provide good strength-weight ratio, using the principle of the waffle, or structurally preformed, units. It would be necessary, however, that they be of the highest type available—as stated, material to be suitable for this purpose must possess extremely low water-absorption properties. Apparently it has not been possible to get plastic molded units of high enough grade at a low enough price. The plastic airplane, therefore, while not an impossibility, requires the use of materials of better grade at a considerably lower price than now available.

TABLE 3

Column Tests—Balsa Wood Sandwich

Specimen	Length, In.	Width, In.	Thickness, Total In.	Ply 12°	Weight, Lb. per Sq.Ft.	Ult. Load, Lbs.	Ult. Load, Lbs. per In. Width	Weight Effec.
1	9.3	10.32	0.679	7	0.821	12,000	1,159	1,410
2	9.36	10.35	0.482	7	0.723	7,800	754	1,040
3	9.31	10.31	0.387	7	0.629	7,150	692	1,100
4	9.34	10.28	0.669	5	0.852*	13,900	1,352	1,590
5	9.32	10.32	0.472	5	0.606	7,500	726	1,200
6	9.32	10.36	0.319	5	0.543	5,350	516	950

* Balsa wood core above average weight used for other panels.

Metals

(a) *Aluminum.* Aluminum is the metal that apparently will offer the best properties at the lowest price for airplane construction for some time to come. Its basic price of around 42 cents per lb. is not too high for light aircraft in which, if aluminum is used, its total weight in the structure would not run over 300 or 400 lbs. Aluminum can be used for all parts of the fuselage and wing, and while such construction is not at all common in the present light airplanes, nevertheless it would be desirable if it could be produced at low enough cost. It will be shown in this paper that the use of wood wing beams and any type of wood monocoque fuselages is false economy, and that with adequate tooling they could be made of aluminum. Aluminum alloy will be displaced as the optimum frame material only when some of the cheaper materials, such as low-cost steel, may be made strong enough to compete on a strength-weight ratio. One adaptation that has not been used in production on light airplanes is the sheet-metal wing covering construction. Designs are under way now, however, which will probably show that the sheet-metal wing skin is more economical in cost and weight than the metal wing with fabric covering. This will be covered more fully later in this paper.

TABLE 4

	Alloy No.		Composition						Physical Properties			
	American Magnesium Co.	The Dow Chemical Co. No.	Silicon	Impurities	Aluminum	Magnesium	Zinc	Manganese	Tensile strength, lbs. per sq.in.	Yield strength, lbs. per sq.in.	Elongation in 2 in., %	Weight in cu.in.
Sheet and shapes	AM 230	Dowmetal 01HTA shapes	0.3 0.7	0.5	9.0 11.0	Balance	...	0.10 min.	32,000	22,000	1.5	0.066
		Dowmetal HHTA	...	0.5	8.5 9.5	Balance	0.4 0.8	0.13 min.	34,000 to 40,000	20,000	5.0	0.066
Sand cast		Dowmetal H							28,000	28,000	1.5	
		HHT							34,000	20,000	2.5	
Rolled		Dowmetal J-1H							30,000	20,000	4.5	
Extruded		Aged 0–1, heat-treated							40,000	25,000	5.0 to 7.5	

Modulus of elasticity, E = 6,500,000. Weight per cu.in. = 0.066 lb.

One of the newest metals that is going into immediate light airplanes is ALCOA 75S alloy, the properties of which are extremely desirable. The mere substitution of this material in place of 24ST has had the effect of raising the allowable gross weight of at least one type of light airplane.

(b) *Magnesium.* One of the direct results of the war has been the great increase in the use of magnesium alloys, chiefly in the form of castings. This material has good mechanical properties, particularly in regard to the strength-weight ratio, but it is subject to corrosion unless well protected. It is believed that experience with it during the war has contributed considerably to a knowledge of adequate protection for it and its use seems to be recommended. While few of the present light airplanes have made use of it, that is because most of them are still prewar designs. Magnesium gives superior quality castings and, in general, better casting work can be done with it than is possible with the aluminum alloys. Table 4 shows the properties of some of the common magnesium alloys.

History of Previous Use of Materials

The first airplanes were built of wood. Attempts were made to use aluminum at a rather early date in spite of its high cost but the first metal to be largely used was steel in the form of steel tubing. Welded steel tubing for fuselages was originated during the first World War and used for commercial fuselages immediately afterward. It is still the most commonly used commercial form of fuselage for small airplanes.

Plywood monocoque construction was used about the period of World War I for fuselage purposes and extended for some years after for some special monocoque fuselages where fabrication considerations and smoothness of contour were thought to favor the use of this material. It was subsequently discarded for metal monocoque or semimonocoque constructions using aluminum-alloy-sheet skin and reinforcing members. This may now be said to be the most desirable fuselage material and is incorporated in all the high quality transport and nearly all the combat airplanes. However, it is by no means commonly used on light airplanes, only two production planes having used it to date. The conventional material is welded steel tubing, fabric covered, a questionable combination for future designs.

The wing materials of construction have been wood; a sprinkling of metal parts being used from time to time; and an epidemic of plywood-covered wooden wings in the late twenties.

The molding methods, such as Duramold, using basic wood materials with plasticizing binders, are simply alternate methods of fabricating wood. Some of these processes have been tried in production but it is not believed that they have been used to any large extent.

The methods, however, are being advocated for light aircraft.

Small parts of synthetic plastics have been used for years. These include pulleys, numerous electrical system parts, and other small solid units. During the last few years larger assemblies have been made of plastics, such as fairings and nose fuselage assemblies.

It was previously mentioned that magnesium castings did not come into their own until the recent war. At the beginning of the war the Navy Department was reluctant to permit their use because of the possibility of corrosion. Their subsequent use shows that, with adequate protection, they were found to be desirable. Toward the end of the war the Navy Department actually requested that magnesium castings be used as much as possible for Navy aircraft armament and, since these were continually used on salt water, it can be assumed that the corrosion problem was overcome. Magnesium castings have extremely good shock-absorbent qualities and are desirable from the engineering point of view. Their cost is still high but it should be remembered that they can replace a good deal of aluminum and probably will be no more expensive than aluminum alloy on the same location. They also have the advantage of weldability without appreciable loss of strength, which is not true of competitive alloy castings or forgings.

Magnesium sheet has not been used extensively in this country but many of the German fighters (for example, the Messerschmitts) had magnesium-sheet wing coverings. From an engineering point of view stressed skin is a good usage for magnesium.

Considerations of Desirability

Reliability

It is axiomatic that the private airplane structure be thoroughly reliable. Even if all occupants are equipped with parachutes there are always portions of each flight in which structural failure would be fatal. The private owner must therefore be assured that there is absolutely no chance of failure of the flight structure. From this point of view it would seem that metal, particularly steel, would be most desirable. However, all materials have their possible faults and metals can fail because of fatigue or corrosion. On the basis of results of service history, the order of reliability may be set down as follows: (a) riveted aluminum alloy sheet, (b) welded steel tubular structures, (c) fabricated aluminum extrusions, (d) plastic and wood combinations, (e) built-up wood.

This assumes, of course, that the structures are in good condition although it may be said that none of them will fail if in the proper condition.

The three types of aluminum-alloy corrosion may be grouped as follows: (a) chemical solution (oxidation), (b) intergranular, (c) electrochemical.

Of the three, the intergranular type is the most dangerous since it is not subject to outside inspection. This form of corrosion spreads out internally along the grain boundaries and greatly weakens the material. However, some moisture must be present. Metals most subject to this type of corrosion are the high-strength 17 and 24 heat-treated aluminum alloys and the austenitic chromium-nickel stainless steels such as the 18-8 types 301, 302, 313 and, under severe conditions, type 304. Intergranular corrosion can always be traced to improper heat-treatment. This is true of both aluminum alloys and stainless steel.

The writer is so optimistic regarding the future of magnesium sheet and castings in light airplanes that the bugaboo of corrosion and its prevention will be fully discussed.

The usual treatment is as follows:

(a) Protection during machining (castings) using light oil.

(b) Protection during storage with chrome pickle as applied by producer.

(c) Final finish by:

(1) Degreasing with solvent.

(2) Alkaline cleaning.

(3) Dow No. 7 chemical treatment.
(4) One coat of P-27 baked primer (zinc chromate).
(5) Two coats of specification E-5e enamel, baked. Additional protection is recommended for exposed air-frame parts.
(6) An additional coat of P-27 primer.
(7) Two coats of AN-T-T-L-51 lacquer, pigmented, air dried.
(8) Two coats of AN-T-T-V-118 varnish, pigmented with aluminum powder, gives additional protection (the maximum for extreme salt-spray conditions).

The protection of faying surfaces (dissimilar metals to prevent electrolytic action) has been found to be satisfactorily accomplished with the use of the comparatively low priced P-27 paint or paste.

The relative corrosion-resistant properties of magnesium structures so treated have been investigated.[5] Table 5 would indicate that magnesium properly paint-protected should give no more trouble than other metals and the materials are easily applied.

Cost

This discussion is of course greatly affected by cost considerations. In aircraft production a material must have a reasonable application price regardless of its other features, and it would be of value to examine some postwar material cost estimates for light aircraft. (See Table 6.)

Table 7 shows that although magnesium is more expensive than aluminum, the difference is only about 50 per cent more by weight and it is the same price by volume. The stainless steels are comparatively expensive.

The joining of magnesium by any of the several approved welding techniques can simplify fabrication. This is an advantage not possessed by the heat-treated materials. The strength reduction on castings by the Heliarc process (in which a stream of helium prevents oxidation) is extremely small and can be neglected for practical considerations. The efficiency of such welded parts is usually between 85 and 95 per cent of the original and, since the castings are not designed to this proportion of the ultimate strength, this is not a fault.

Similarly, magnesium sheet from 0.051 gage up may be welded. Wing covering might be readily built up in this manner. The sheet cost is about 60 cents per lb. The casting cost is about $3.00 per lb. These castings require little fabrication since their surface quality is easily controllable both dimensionally and in finish.

The weldability of magnesium is one of its outstanding features. When welding sheet magnesium with butt or fillet welds, it is not uncommon to produce welds with efficiencies of 85 to 90 per cent, a figure practically impossible to obtain in the welding of any of the aluminum alloys. Also, there is little discrepancy in weldability among all of the magnesium alloys, whereas in aluminum it is difficult to weld the structural alloys.

New rubber blanket materials recently developed by the large rubber companies now make it feasible to produce magnesium parts by the Guerin process at sustained temperatures of 450°F., placing the material on a competitive basis with aluminum in this respect.

Life in Service

(a) *Servicing Cost.* Aluminum alloy, such as Alclad sheet, requires only occasional washing with water and polishing. Severe air-line experience has shown that it is an excellent material from the point of view of maintenance. Other aluminum alloys (i.e., not Alclad) are more subject to corrosion. However they are used internally and may readily be paint protected. Their subjectivity may be classed as follows: (1) most active—14S, 17S, 24S, 75S; (2) less active—53S, 61S; (3) least active—the Alclad sheet materials.

Other metals, such as steel and magnesium, must be fully paint protected, but in good design this does not constitute an appreciable service cost. The exception to this may be exposed steel tubing.

Wood constructions, particularly wood monocoques, must be carefully watched and retouched to prevent weathering, representing a serious service problem. This may be partly avoided by using doped fabric covering, in which case the service would be about the same as for fabric-covered wings. This increases the manufacturing cost considerably.

Experience with the plain monocoque plastic bonded fuselage has not been satisfactory. A test fuselage (3-ply poplar plastic molded), made by an approved welding process, was placed outdoors in February, 1942. This was part of a test airplane and had been completely sealed, finished, and painted. After 6 months the wood had opened up between the joints of the outer ply butts at all points. To keep this fuselage safe outdoors would have required almost continual retouching of the seam coverings, apparently because of relative motion of the wood panels with atmospheric changes.

(b) *Expectant Life.* The private owner can, and will eventually, expect the same trouble-free life from his airplane as he now does from his car body. The remarkable record of air lines during the war shows that it is possible for metal air frames and fuselages to last for extraordinarily long periods. Although

TABLE 5
Effects of Corrosive Exposure

Alloy	Protection	Atmospheric 2½ Years	20 Per Cent Salt Spray 1,000 Hours at 95°	Seacoast
J1	Dow No. 7 plus 2 coats P-27 plus 2 coats L12 plus A1 (or 2 coats V10)	No loss	No loss	.....
H	None	4% loss	.....	1% loss
H	Dow No. 7 plus 2 coats P-27 plus 2 coats V10 plus A1	No loss	.....	No loss
J1 to 24ST Alclad	P-27 plus V10 = A1	No joint corrosion	No joint corrosion	None at 5 months
J1 to 24ST Alclad	56 rivets sealed and painted	No joint corrosion	No joint corrosion	None at 5 months
J1 to 24ST	56 rivets sealed and painted	No joint corrosion	No joint corrosion	None at 5 months

TABLE 7*
Cost of Aircraft Metals

Material		Price	
Number	Form	Per pound	Per cu.in.
	Aluminum Alloys		
17ST	Tube	1.40	..
24ST Alclad	Sheet	0.42	0.04
195-T4	Casting	1.00	0.11
220-T4	.....	1.00	0.11
	Magnesium Alloys		
M Alloys	Sheet	0.60–0.80	0.03
E Alloys	Sheet	0.90–0.70	..
H Alloys	Casting	2.00	0.13
	Steel Alloys		
2330	Bar	0.15	0.04
X-4130	Bar	0.15	0.04
	Stainless Steel		
18-8	Sheet	0.70	0.19
18-8	Bar	0.55	0.15

* Revere Copper & Brass Company.

TABLE 6

Cost Analysis of Plastic and Metal Counterparts[4]

(1)	(2)	(3)	(4)	(5)	Cost Breakdown ($) (6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)
Part	Material	Type	Weight Lbs.	Pattern or Die ($)	Core	Molding and casting	Material cost	Finish and cleaning	Heat-treat	Sand blast	Rejection and waste	Machining	Component parts	Unit Cost	Total Cost*
Ammunition roller (0.50 cal.)	AB	IM	0.0837	1,650	...	0.042	0.046	0.034	...	....	...	....	0.158	0.122	0.28
	AL[1]	DC	0.10	965	...	0.088	0.036	0.175	...	....	...	....	0.158	0.299	0.457
Trim tab operating drum	CFP	CM	0.19	2,250 (4 Cavity)	...	0.200	0.090	0.111	...	....	0.040	....	...	0.441	0.441
	AL[1]	DC	0.20	975 (2 Cavity)	...	0.293	0.072	0.435	...	....	...	....	...	0.80	0.80
Elevator and trim tab control wheel assembly	CFP	CM	0.319	1,375	...	0.48	0.137	0.20	...	....	0.05	0.06	0.35	0.867	1.22
	AL[1]	DC	0.40	745	...	0.32	0.144	0.405	...	....	...	0.94	...	0.869	1.80
Escape hatch handle	MP	CM	0.088	1,160 (2 Cavity)	...	0.15	0.048	0.0375	...	....	...	0.009	...	0.235	0.244
	AL[1]	DC	0.12	795 (2 Cavity)	...	0.073	0.043	0.070	...	....	...	0.055	...	0.186	0.241
	CFLP	CM	0.12	590	...	0.132	0.054	0.010	...	....	0.010	....	...	0.206	0.206
Heating and ventilating system cold air control sector	AB	IM	0.10	1,250	...	0.025	0.073	0.022	...	....	...	....	...	0.12	0.12
	AL[1]	DC	0.14	995	...	0.088	0.050	0.18	...	....	...	....	...	0.318	0.318
Fuel cell support	CP	CM	0.117	650 (4 Cavity)	...	0.092	0.050	0.041	...	....	0.022	0.04	...	0.205	0.245
	AL[2]	PSCM	0.17	120 (3 Cavity)	0.08	0.12	0.026	0.020	0.020	0.0085	...	0.52	...	0.275	0.79
Self-sealing fuel cell flange	CP	CM	0.59	1,700	...	0.53	0.20	0.186	...	....	0.08	0.15	...	0.996	1.146
	AB	CM	0.59	1,700	...	0.55	0.358	0.08	...	....	...	0.02	...	0.988	1.008
	AL[2]	SC	1.40	160	0.514	0.36	0.210	0.288	0.140	0.028	...	4.44	...	1.54	5.98
Fuel cell gage support flange	MP	CM	0.88	2,000	...	0.73	0.299	0.27	...	...	0.07	0.18	1.12	1.359	2.659
	AB	CM	0.84	2,000	...	0.79	0.508	0.04	...	....	...	0.09	1.12	1.338	2.58
	AL[2]	SC	1.750	264	0.776	0.36	0.263	0.20	0.175	0.035	...	4.78	...	1.81	6.59
Bomb rack housing assembly	MP	CM	7.13	4,000	...	3.00	6.65	4.00	...	....	...	6.35	...	13.65	20.00
	Mg	SC	9.64	450	6.88	3.50	2.70	3.30	2.30	0.48	1.94	19.47	...	21.40	39.75
Carburetor air duct edge	FCG	LPL	2.50	647	...	12.05	5.90	0.55	...	....	2.00	3.50	...	18.50	24.00
	Mg	SC	4.70	450	4.50	2.50	10.48	0.60	0.56	0.25	0.60	11.26	...	19.89	31.75
	Mg	PM	4.70	11,000	...	0.85	10.48	0.40	0.56	0.25	0.30	1.52	...	12.54	14.36
Fuel transfer valve dial	AB	IM	0.052	1,000	...	0.035	0.031	0.050	...	....	...	....	0.04	0.116	0.156
	AL[1]	DC	0.104	950	...	0.085	0.025	0.10	...	....	...	....	0.04	0.210	0.250

AB = Acetate butyrate, AL[1] = Aluminum 13 (AN-QQ-A-366), CEP = Cord-filled phenolic, MP = Macerated phenolic, CFLP = Cotton flock phenolic, CP = Cord phenolic, AL[2] = Aluminum 356T6, Mg = Magnesium, FCG = Fabric, canvas, and glass, IM = Injection molded, DC = Die casting, CM = Compression molded, SC = Sand casting, LPL = Low-pressure laminated, PM = Permanent mold, and PSCM = Permanent sand casting molded.

* Total of Columns through 14.

other materials may also do so, they do not appear so attractive from this point of view.

Relative Desirability of Materials

It is not surprising from the preceding considerations of magnesium to find that a magnesium test wing built and subjected to exhaustive tests in comparison with an aluminum wing, gave favorable results. The tests were made at the Naval Aircraft Factory, under the direction of the Bureau of Aeronautics.

Design of the SNJ-2 Wing

This wing passed the required service tests and therefore was said to have been adequate in strength and endurance. Table 8 shows the wing weight results.

TABLE 8
Comparison of Weights of Aluminum and Magnesium Outer Wing Panels for the SNJ-2 Airplane

Item	Aluminum, Lbs.	Magnesium, Lbs.
Main beam	17.8	14.98
Auxillary beam	3.8	3.10
Ribs	13.25	11.64
Stringers	38.6	33.25
Metal covering	78.3	57.65
Miscellaneous items	27.75	32.31
Paint	2.0	5.73
	181.50	158.56
Aileron	24.00	18.00
Flap	7.00	5.65
	212.50	182.21

Table 9 shows that from the engineering point of view of secondary failure as influencing skin design, the weights of magnesium are favorable. Since this means the substitution of a light, thick single member for thin-skinned complex structures, the cost is also decreased.

It may appear that steels have not been adequately considered in this review. They have been considered, but, except for their use on landing gears, engine mounts, and machined surface points, their future use does not appear promising. In other words, the present use of steel tubing for landing-gear elements and engine-mount structures appears advisable and economical because of the specialized requirements of these parts, but extension of its usage to other structural parts does not appear desirable. The reasons for these conclusions are:

(1) Welded tubular structure makes excellent engine mounts because of compactness, fatigue resistance to engine vibration, and the allowance of access to the components.

(2) Heat-treated steel tubing will be used for landing gears because the required high strength in limited space can thus be obtained.

(3) Welded steel fuselages are not economical because the fabrication-plus-maintenance cost is higher than that of sheet-metal construction. Also, they are not so desirable from other aspects, such as minor injury, weathering, general appearance, and easy protection of passengers and baggage.

(4) The cost of stainless-steel sheet for private airplanes is prohibitively high.

(5) The use of low-cost strip for a fabricated steel structure is attractive but there are several considerations that prevent its realization. These are: (a) To compete with aluminum in weight, a strength of about three times the strength of aluminum must be obtained. In many structural parts this would be a minimum of 180,000 lbs. per sq.in. Such strength requires heat-treated steel that is undesirable for general private airplane body or wing construction since it prohibits the making of field repairs by welding. Heat-treated parts replaceable as units are acceptable, but in large assemblies they are undesirable. (b) Because of weight competition most of these sheet parts would have to be of such thin gage that corrosion protection would become a serious problem.

DESIGNS AS INFLUENCING USE OF MATERIALS

Sources of Materials

It had been believed that attempts would be made to continue in production many of the facilities that sprang up during the war, making large supplies of magnesium and aluminum in their various forms available at low cost. However, it is now apparent that no attempt will be made to maintain these facilities and that labor cost will be the main criterion in the price of the materials.

It was also believed that many of the smaller subcontractors who had been educated to make metal airplane parts during the war would attempt to stay in this business. This situation might have caused the economical production of metal airplane parts on a subcontract basis, but it is now apparent that many of these small shops will either close up or return to their former type of manufacturing and that the aircraft companies will be glad to handle all their own fabricating because of greatly reduced orders.

Consequently, there will be no scarcity of facilities for the manufacture of the materials but no reduction in prices over those in effect before the war may be expected, unless a great change takes place in the labor market.

Influence of Monocoque Fuselage and Cantilever Wing

It is apparent that the trend of design is principally toward the metal monocoque fuselage and cantilever wing, which has been publicized by the large number of such designs in use during the war.

The general demand for aircraft that resemble transport or military airplanes has undoubtedly accelerated the trend toward metal and the elimination of fabric fuselage covering. It may well be argued that since people will not buy a wooden automobile with fabric covering, they will at least expect a metal covering on their airplane fuselage.

Designers are beginning to be asked "Why not use a cantilever wing and save the cost of additional bracing parts?" This is in addition to the performance considerations usually associated with such design. The writer thinks it is now time to begin to ask, "Why not use the right light metals in thick gages and save the cost of most of the internal auxiliary parts?" In other words, it should be possible to bring the principle of the self-stabilizing cantilever structure into the subassembly parts to save fabricating costs.

Efficient Wood Design

One of the most successful wooden designs is the de Havilland Mosquito. Although it is not in the private airplane class it has obtained so much notice that it cannot be disregarded.

The type of structure used is the split fuselage monocoque, joined along a longitudinal centerline. The wing is built in one piece with full-length box-type spars and has a double top plywood skin of 0.25-in. thickness, each separated by fir stringers. This construction is not the usual plywood monocoque simple skin or the simple spruce wood beam. It is rather an elaborate composite mosaic using many different built-up cell-like sandwich units. Thus the fuselage is of double skin, two 0.062 three-ply skins being separated by a balsa spacer of 0.437-in. thickness. The balsa must be graded by weight, that used being about 9 lbs. per cu.ft. in density. The kind of plywood, as well as the grain direction, varies with the location and the principal stress at the point of application.

TABLE 9
Relative Strength and Stiffness in Bending of Structural Metals (Rectangular Beams of Constant Width Using 1025 Steel as a Basis of Comparison)

Comparison	Material	Thickness	Strength	Stiffness	Weight
Equal strength	1025	100	100	100	100
	X-4130	72	100	38	72
	24ST	95	100	31	33
	FS-1h	121	100	36	27
	0-1-HTA	110	100	30	25
Equal stiffness	1025	100	100	100	100
	X-4130	100	194	100	100
	24ST	141	221	100	50
	FS-1h	165	185	100	37
	0-1-HTA	165	227	100	37

The two halves of the fuselage are joined by a reinforced seam and junction of the bulkheads. After completion the entire airplane is covered with Mandapolan, an airplane fabric, which is given several coats of dope and polished. It is understandable that such extreme refinement of the load-carrying members (i.e., double skinning to prevent local column deflections) would produce an efficient structure. It is not believed that such construction is of low cost. If materials could be furnished in prefabricated cellular units as mentioned for the hypothetical plastic waffles, then the project might become feasible. The problem of building up an airplane of basic sheets and blocks in this manner could never compete economically with metal construction. Some of the reasons for this conclusion may be given.

(a) The proper grade of balsa required would make the material cost high.

(b) The time element involved in gluing so many small pieces together would work against quantity production.

(c) Material control with so many varieties of wood products would be too expensive.

(d) After completion of the structure, it is still necessary to cover, dope and polish it.

The metal skin does not require these additional costs. The cost of dope, incidentally, cannot be lowered appreciably by quantity production.

Efficient Metal Designs[9]

Another development was in the design of the Erco light airplane wing. It was a simplification of some of the earlier monospar systems in which a single beam was braced torsionally by means of an elaborate tie-rod system. The tie-rod system was replaced by simple, diagonal ribs and a light rear beam capable of taking moderate compression as part of the chord load system.

What was desired was a light, simple, and inexpensive wing constructed entirely of metal except for the fabric covering. Metal covering was erroneously thought to be too heavy for a lightly loaded wing. The usual drag bracing with tension tie-rods was considered too complex, and the "D"-type section formed by a metal skin over the leading edge gives a closed section with rivets accessible on the outside only. In order to avoid blind rivets, the nose sheet was made to cover only the upper surface and front portion of the nose ribs.

The diagonal rib system that was adopted for torsional and drag bracing is also used to form the contour of the wing between the main beam and the aileron. Several factors combine to make this arrangement satisfactory. The airfoil used, the NACA 43013, has its maximum camber only 15 per cent back from the nose and the sheet-metal nose covering goes back 27 per cent on the upper surface. The curvature of the surface is, therefore, extremely small over the portion of the wing taken up by the diagonal ribs. In addition, the air load on the fabric when the airplane is in flight tends to raise the fabric slightly and the upper surface contour is close to that desired.

Incidentally, the airfoil section used has a low moment coefficient, but the gain from low center of pressure travel was not so great as might have been anticipated since the wing must be designed for high speed with deflected aileron. It did, however, indicate the optimum location for the main beam.

The actual structural problem then became the design of (1) a light main beam capable of carrying the total bending moment with no assistance from any other part, and (2) the diagonal rib system to resist all torsional moments about this beam as an elastic axis, plus the rib air loads, plus the chord components loading these members as parts of a Warren truss.

The structure was considered determinate, moments transmitted through the joints or equalized by the rear beam being neglected. Subsequently, proof loads were applied to a completed wing and a deflection analysis made. This showed the original analysis to be substantially correct.

The main beam was of a tension field extruded cap-strip type, not an expensive one to make when an automatic riveting machine is available. These extruded cap-strips were machined down in section outboard by means of a milling machine and tapered forms. This is a refinement necessary from the weight standpoint if a continuous extrusion is used.

Since the wings are not tapered, the ribs are all of the same section except, of course, at the tip. This means that there are extremely few different shapes and forms to make, resulting in easy production and assembly.

Stress Analysis Briefs

General Design Considerations

The general stress analysis criterion for skin stressed members—that allowable stress is equal to thickness divided by radius of curvature × modulus of elasticity—had been accepted as standard for most skin stressed bodies. This made it convenient in comparing materials. It seemed obvious that since the moduli of elasticity of the aluminum alloys are about the same almost any of them could be used for this purpose. It can be shown, however, that the yield point is also a pronounced design feature in these structures. The newer methods show that constants derived from the yield strength of metals are important. This leads us to the conclusion that the use of the new 75 aluminum alloy will increase the monocoque skin stress of structures, also that magnesium-alloy sheet is fairly efficient structurally in spite of its low modulus of elasticity. A comparison of the various skin types of metals in thickness, weight, and strength is shown in Table 10.[8]

It has been shown that a semi-monocoque construction with sheet stringer combination is lighter than a similar aluminum combination. Design data for magnesium are not as complete as for aluminum alloy; however, some of the same empirical formulas may be used for both materials. In discussing this stiffened sheet stringer combination, the formula generally used for a design is as follows:

$$\frac{P}{A} = f_{yp} - \frac{f^2_{yp}(L/r)^2}{4c^2E}$$

The method used for dimensioning the effective width of sheets stiffened by the stringers may be given by the formula

$$b_c = 1.7t(E/f_c)$$

If we assume a typical design problem and pick suitable sizes we may compare the two materials directly. For example, in the case of aluminum assume that:

Angle = $^5/_8 \times 0.078 \times 0.050$ in.
Angle area = 0.111 sq.in. (actual by weight)

If the area of the angle is 0.111 sq.in., then the effective width of the sheet would be

$$b_c = 1.7 \times 0.032\ (10 \times 10^6/36{,}000) = 0.91 \text{ in.}$$

Then the section properties of the combination angle plus sheet working together would be

$A = 0.140$ $\quad r = 0.36$
$I = 0.0143$ $\quad L/r = 41.6$ (for 15-in. column length)

Substituting in the first formula:

$$P/A = 42{,}000 - \frac{42{,}000^2 \times 41.6^2}{4 \times 2^2 \times E} =$$

$$42{,}000 - 3{,}900 = 38{,}100 \text{ lbs. per sq.in.}$$

We may assume that the b/t ratio for the aluminum angle will be approximately correct for an equal weight for

TABLE 10
Comparative Properties of Wrought Magnesium and Aluminum Alloys

Alloy	Form	Typical Properties Tensile: Ultimate strength, lbs. per sq.in.	Yield strength, lbs. per sq.in.	Elongation, per cent
Dowmetal O-1A	Extruded	49,000*	32,000*	7
24ST	Extruded	57,000†	42,000†	12
Dowmetal J-1h	Sheet	47,000*	34,000*	9
24ST	Sheet	62,000†	40,000†	16

* Tentative specifications, The Dow Chemical Company.
† Specified values, ANC-5.

the magnesium angle. Since the magnesium sheet gage may be increased without undue loss of weight we may increase this by 50 per cent to obtain the same weight in magnesium. Then the angle area = 0.161 sq.in., and the effective sheet width of the magnesium combination would be 1.7×0.048 ($6.5 \times 10^6/30{,}000$) = 1.2 in.

Substituting in the first formula and allowing a compressive yield strength of 34,000, which is conservative,

$$P/A = 34{,}000 - \frac{34{,}000^2 \times 35^2}{4 \times 2^2 \times E} =$$

$34{,}000 - 2{,}750 = 31{,}250$ lbs. per sq.in.

The total load carried by the angle sheet comparison would then be

$$p = 0.224 \times 31{,}250 = 7{,}000 \text{ lbs.}$$

This load results in an increase over the equal weight of aluminum combination of

$$(7{,}000 - 5{,}340)/5{,}340 = 31 \text{ per cent}$$

In other words, the structure of a semimonocoque skin reinforced wing, which is to say the allowable loading on the airplane, can be increased as much as 31 per cent without increasing the structural weight over that of the aluminum sheet stringer combination.

In another case in which a nonreinforced thick-skin structure is contemplated, magnesium also shows up favorably. It should be remembered that this type of construction is essentially more economical since it does away with the multiplicity of small parts in the structure.

In this case a pure monocoque design will be used, taking as an example the one given on page 172 of *Airplane Structures* by Niles and Newell. The properties of the section are:

(a) radius of curvature = 20 in.
(b) skin thickness = 0.020 in.
(c) reinforcements = 16 channel stiffener forms from 0.032 sheet.
(d) design bending moment = 330,000 in.lbs.

The section required to take this load weighed 4.05 lbs. per ft. length. The weight of both aluminum and magnesium monocoque without stiffeners will be determined in order to check the loss of weight due to removal of the stiffeners. In this case:

$$F_{all} = 0.25Et/R$$

It is believed that this formula is extremely conservative for magnesium since it does not allow for the high yield strength as compared to its relatively low modulus of elasticity.

The computations work out as follows:

$$F_{all} = \frac{0.25 \times 10^7 t}{20} \quad \text{for aluminum}$$

$$F_{all} = \frac{0.25 \times 6.5 \times 10^6 t}{20} \quad \text{for magnesium}$$

Table 11 shows that the monocoque aluminum sheet would have to be 0.046 in. thick and the magnesium 0.057 in. thick. This shows that the aluminum sheet would weigh 73 per cent more than the reinforced type of aluminum structure, while the magnesium shell would weigh 37 per cent more than the semimonocoque structure of magnesium. This indicates that magnesium is relatively advantageous to use in the heavy skin nonreinforced type of structure.

TABLE 11
Tabulation of Results for Various Thicknesses

Thickness, In.	$1/C = tR^2$	$f = M/S$	Al $F_{all} = \frac{0.25 \times 10^7 \times t}{R}$	Mg $F_{all} = \frac{0.25 \times 6.5 \times 10^6 \times t}{R}$
0.040	50	6,600	5,000	3,250
0.045	56.6	5,840	5,625	3,660
0.046	58	5,700	5,750	3,740
0.050	65	5,070	...	4,060
0.057	71.5	4,620	...	4,640

Conclusions

Assuming that metal skin structures are desirable, a review of the field of all materials acceptable reveals that by far the most interesting is metallic beryllium. Knowing the properties of magnesium and steel sheet, it is at once apparent that if a material could be found possessing the same weight as magnesium and the modulus of elasticity of steel it would make an extremely desirable monocoque fuselage or wing. Metallic beryllium, having a modulus of elasticity of approximately 30,000,000 and a density of about 0.06 lbs. per cu.in. falls into this category. It can be shown that a fuselage could be made satisfying all requirements and weighing about one-half as much as one of aluminum monocoque if this material could be used. It is disappointing that its price still places it on the prohibitive list.

The relative cost, coupled with other questions of desirability, would indicate that the best construction for immediate use in the next few years would be a welded aluminum-alloy fuselage and some type of aluminum beams with a magnesium skin. It appears that increasing the skin gages of both the wing and the fuselage can be done economically without much increase of weight if the proper structural design is used. Such a construction would be trouble-free, and would not be liable to damage due to handling or fatigue failure due to "oil can" of thin skin. Also, it would have the advantage of being thick enough to permit detection of corrosion before a percentage sufficient to cause failure could be effected. Furthermore, fabrication costs would be less because much riveting would be eliminated and large amounts of welding on final assembly could be done on both the fuselage and the wing covering.

As previously mentioned, unless great improvements take place in plastic materials or metallic beryllium is made available in economically feasible quantities, the thick-skin welded aluminum monocoque fuselage with a thick-skin magnesium covered wing seems to be indicated as desirable.

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Changes of Address

To facilitate the prompt receipt of copies of the JOURNAL and REVIEW, members and subscribers are requested to give the Institute 30 days' notice of any change of address.

Notices should be sent directly to the Institute of the Aeronautical Sciences, 2 East 64th Street, New York 21, N.Y.

The New York Building of the Institute of the Aeronautical Sciences, Inc.

Introduction

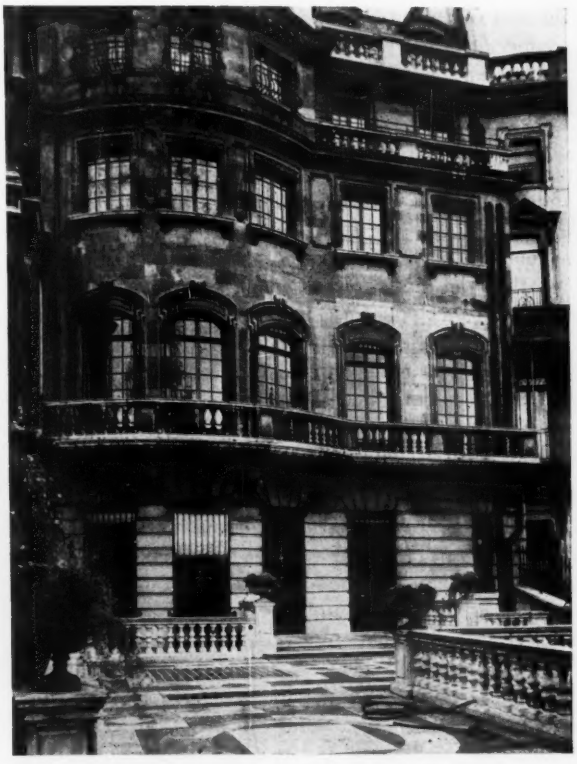
IN THE DAYS when ballooning was a popular sport in the United States and mechanical flight was only in the speculative stage, several organizations were formed to further the interest of their members—one in Boston, one in Philadelphia, and two in New York. One in New York was interested in the scientific study of flying machines, held contests, and had an experimental station. The other occupied a handsome residence building at the corner of Madison Avenue and Forty-First Street. When some of the members became interested in mechanical flight they were regarded as fanatics. Aviators and airplane constructors were looked on as showmen and mechanics. It was only when the Wright Brothers demonstrated to an incredulous world the possibilities of mechanical flight that the lighter-than-air devotees were willing to fraternize with the newer class of pioneers.

Since those early days no membership aeronautical organization, except the Institute of the Aeronautical Sciences, has attempted to operate, much less own, a building in which it could render services to the public and to the aeronautical scientists and engineers whose skill and ability will be responsible for advancing the science of aeronautics and for keeping American aeronautical design in advance of developments in other countries.

With the Institute of the Aeronautical Sciences having one of the mansions of New York as a center for the dissemination of aeronautical knowledge, it is interesting to compare its facilities with the aeronautical organizations in other countries.

Library of The Royal Aeronautical Society.

Meeting Room of the Lilienthal Society.



The Royal Aeronautical Society, London.

Members' Lounge in The Aero Club de France, Paris.

Buildings in Europe

In Europe, there was a much greater effort made to provide confortable and even elaborate buildings where airmen could meet and have an interchange of mutually interesting scientific, engineering, and economic ideas. The oldest of all organizations of airmen is The Royal Aeronautical Society of Great Britain.

Several years ago, an ambitious plan was undertaken by the R.Ae.S. A fund of over £100,000 was raised, a palatial house overlooking Hyde Park in London was remodeled and elaborately furnished. Now this oldest aeronautical organization in the world can look back to its eighty years of accomplishment from its own home, with its valuable library and many other facilities for the use of the public and aeronautical scientists and engineers. Sir Frederick Handley Page, President of the R.Ae.S., is one of the six English Honorary Fellows of the Institute.

In only one other country was there a scientific aeronautical society with a home of its own. The scientists and engineers in all countries were few in number compared to the many who wanted to make ascents in balloons or fly in some sort of a machine. The result was that the pilots formed many societies where they could discuss flying, organize races, and issue licenses. These organizations prospered, but the scientific groups were small and financially weak in comparison. Pilots became accustomed to luxurious surroundings, but until the last few years engineers had to hold their meetings to exchange ideas about the aeronautical sciences in inadequate quarters.

The Nazis, with typical ostentation, decided that their aeronautical organizations should be housed in the grand manner. The old Prussian House of Parliament in the German capital was redecorated in modernistic style, and suddenly the German aeronautical organizations found themselves housed in a monumental building surrounded by a park in which, significantly, Goering had his home. The Lilienthal Society, comprising the leaders in German aeronautical science, had its offices and library amid this grandeur.

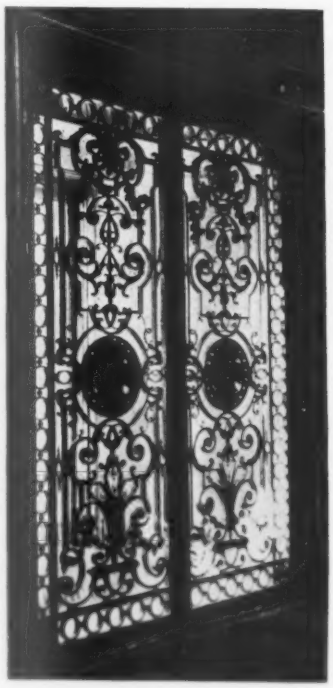
In France there has been no outstanding aeronautical scientific society, but The Aero Club de France has been the headquarters of the Federation Aeronautique Internationale, which licenses airmen and flying meets. It has also been the center for the dissemination of French scientific and aeronautical information. Its President, Baron de la Grange, was a guest speaker at the Institute's Honors Night Victory Dinner in January, 1946.

The future holds promise of better things for those who devote their lives to aviation. Heretofore, such a career was hazardous and had all the instability of pioneering. Times have changed and now the aeronautical profession takes its rightful place in the forefront of world affairs and accomplishment.

The I.A.S. Building Project

The opening of the Institute's new building, with its extensive libraries and museum collections, will now provide, in addition to the services rendered to the public and its seven thousand members in all parts of the country, a place for aeronautical engineers and others interested in aviation to study and enjoy treasured trophies and relics in surroundings comparable to those that have existed in Europe for many years. Now, the public and members may have the privilege of consulting the Institute library of 30,000 books in a comfortable and quiet reading room. Those who live in any part of the country can borrow books without charge and receive them by mail.

When the Institute was organized in 1932 none of the Founder Members had a larger concept of the Institute than that of a small organization to advance the aeronautical sciences. The aircraft industry was at its low ebb of prosperity. Aeronautical engineers who had graduated from technical schools could not find positions. Pilots, other than the few engaged in air transport, eked out a precarious living by barnstorming, private charter, and other services.



Entrance doorway, new Institute building.

Many of the Founder Members had observed the great service The Royal Aeronautical Society had rendered to the public

and the aeronautical profession in England and throughout the world. They decided to model the Institute on its successful program, which had proved to be so beneficial through its long and notable history.

During the first two years after its organization the Institute did not have even an office. It could not afford one. It was the foresight and generosity of Nelson Rockefeller that enabled the Institute to open a small office on the 54th Floor of the R.C.A. Building at Rockefeller Center. When the Journal of the Aeronautical Sciences was started in 1934 more space was needed, and the Institute moved to another floor where double the space was available.

Hallway looking toward the Reading Room.

Pictures opposite entrance doorway.

The Reading Room.

A library was started by a gift of a few technical aeronautical books by Major L. D. Gardner. About the same time, because of the public services rendered by the Institute, it was found that personnel could be obtained from the Works Projects Administration to compile an index of aeronautics. A staff of over one hundred did research and compiling work for several years. This index, which finally comprised over two million cards, was the starting point of the Institute in its library development.

The Aeronautical Archives Organized

In 1939 a decision was made which was to be momentous in the history of the Institute. Mr. Hart O. Berg, who had been closely associated with the early work of the Wright Brothers in France, had a valuable collection of papers, photographs, mementos, etc. He asked Dr. George W. Lewis, then President of the Institute, and Major Gardner, who were in Paris, if the Institute would accept them as a gift. It was then that the decision was made that the Institute provide a place where collections other than books could be assembled.

Ordinarily such a repository would be a museum or specialized society, but, as there was no other aeronautical organization in this country able to maintain such collections, the Council decided to render this additional service to the public, to aeronautical people in general, and to members by creating the Aeronautical Archives.

Part of The W. A. M. Burden Library.

The Institute's Libraries

Mr. W. A. M. Burden, now Assistant Secretary of Commerce for Air, had, over a period of many years, assembled what is undoubtedly the largest private aeronautical library in the world. He offered to loan it to the Institute if adequate reading rooms and shelving space could be provided. This naturally required new and greatly enlarged quarters. The management of Rockefeller Center was most cooperative and the Institute again moved. Even more space was soon needed until, in 1944, the Institute occupied a block front of offices on the Avenue of the Americas side of the building and also offices on another floor for the staff of the Aeronautical Engineering Review and Aeronautical Engineering Catalog.

Gifts then commenced to flow from many generous donors. To exhibit these collections, some of which are of great scientific, historical, and artistic interest, and to provide for the expanded services of the Institute, much more space was needed than could be had in an office building because of limited office space available in New York and correspondingly high rentals.

It became apparent in 1944 that the only solution to the problem of providing the Institute with space for planned postwar activities, its library of 30,000 books, and an exhibition room for the Institute's interesting collections was to purchase a building and to remodel it to suit the Institute's needs.

While a survey of possible properties was being made, Capt. Harry F. Guggenheim suggested that the Institute might find valuable use for the estate of his

Subject and index files.

Bookcases in the basement.

father, Daniel Guggenheim, at Sands Point, Long Island. With the encouragement of Glenn L. Martin, who established The Minta Martin Aeronautical Fund, which now amounts to over a half-million dollars, the estate with its beautiful buildings was given to the Institute by Mrs. Florence Guggenheim in memory of her husband. The Navy is now using this property for postwar research.

New Building Project

Several possibilities in New York City were under consideration when Major R. H. Fleet, then President of the Institute, decided that the time had come when the Institute should have facilities comparable to those of other scientific professions. He was successful in raising funds for buildings for the Institute's sections in San Diego and Los Angeles and then proposed that the Institute should also erect a new building in New York. His plan for a ten-story building costing a

million and a half dollars was considered by several prospective donors to be too remote because of difficulties in securing building material, but they agreed to make contributions for the purchase and remodeling of an existing building so that the Institute could expand its services immediately.

The purchase of the residence of the late E. J. Berwind, facing Central Park at Fifth Avenue and Sixty-Fourth Street, was then considered, and after a sufficient fund had been contributed by generous donors the building was bought and remodeled. It is interesting to note that Mr. Berwind, who had many industrial interests, was one of the five original subscribers to stock in the first company organized by the Wright Brothers and was also a member of its Board of Directors.

Soon after its purchase, in August, 1945, extensive alterations were made in the building to adapt it to

The Council Room.

the needs of the Institute. Every possible requirement of the Building Department of New York City has been met by erecting a large fire escape and by installing fireproof doors and many new exits, but even though the building is rated as "fireproof," the limitations imposed by New York City fire regulations prevent large groups of guests from inspecting the building at one time.

A Visit to the Institute and the Aeronautical Archives

Because of the great value of the exhibits and since guards such as are necessary in public museums cannot be provided, the building can be open to the public other than members only on specified days. As the exhibits are of little interest to children, the Council has decided to limit admission to adults. Later it may

Harry F. Guggenheim collection of aeronautical prints.

be possible for visitors to bring children on certain days. As it takes an hour or more to inspect the exhibits in the building, the Council requests that members do not ask the Institute staff to take them on a tour of the building. A special curator will be available to escort members and others through the building and to describe the collections.

The Ground Floor

Entering through the doors of iron grillwork, the visitor will note the exceptionally fine woodwork adorning the walls of the entrance hall and foyer. To provide the fireproof stairs required in all public buildings, the ornamental staircase had to be enclosed.

The Model Room.

Fireplace in the Model Room.

Facing the entrance, in a niche, is a bronze statuette of Icarus and alongside are two engravings of this mythological flying man. Above is a mural montage, made by the noted photographer, Edward Steichen, including the first flight of the Wright Brothers at Kitty Hawk on December 17, 1903. To the left are pictures showing the development of flight from the early balloon to man's first attempts to fly by mechanical contrivances. There is also a rare signed photograph of Wilbur Wright.

Over the door to the stairway is a watercolor by Clayton Knight showing the shooting-down of Baron Richtofen by Lt. A. Roy Brown. Over the signature of Lieutenant Brown is a piece of the red fabric from Richtofen's biplane. Opposite will be found a list of the contributors to the Building Funds of the Institute. Many other paintings and prints of aeronautical interest are also hung on the walls of the foyer.

The telephone switchboard, with twenty-eight extensions and the center of a complete building intercommunication system, is to the right. The receptionist will be glad to assist visitors in obtaining any information about the Institute and its services.

Throughout the building visitors may see over seven hundred framed pictures of great variety and value. The major portion of these was presented by Captain Guggenheim and Mrs. Bella C. Landauer. Many others were acquired by gift and some by purchase. These pictures permit the Institute to show members and the public a historical record of the art and progress of aeronautics from its primitive beginnings.

The Institute purchased the building unfurnished. The antique furniture and rugs in the house were the gift of Mr. Sherman M. Fairchild.

The Reading Room

The Library Reading Room is open to the public and to members. Its ornamental ceiling is of the period of the home and has three oil-painted murals of "The Graces." Eventually it is hoped that an interested donor will provide murals, showing the epochs in the history of flight, for the wall spaces in this room. Meanwhile, a series of prints by Frank Lemon depicting famous flights and airplanes and five lithographs of early French flying machines are hung on the walls. Off the Reading Room is the librarian's service room with a small electric dumbwaiter to bring books from the bookstacks in the basement.

Members and others may secure a sheet of instructions and rules for ordering books both for use in the Reading Room and for loan from The Paul Kollsman Lending Library, which was endowed by Mr. Kollsman. Books are borrowed by mail without charge by over 4,000 persons, many of whom are not members of the Institute, through this special library service.

The Council Room

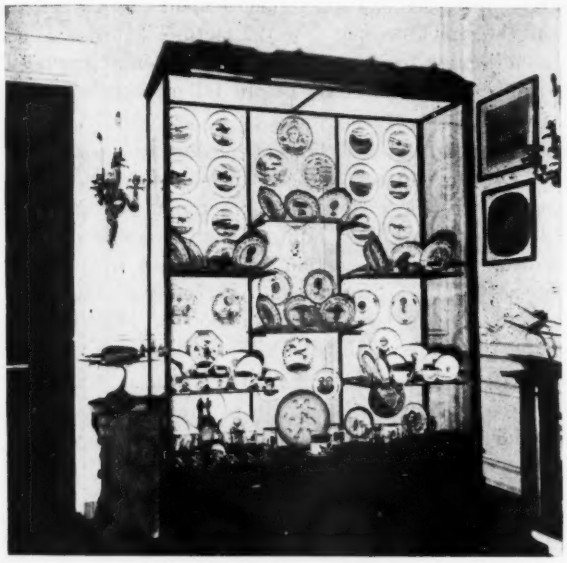
At the other end of the hall is the Council Room, said to be one of the most handsome rooms in the United States. The matched mahogany was fabricated in France in the style of The Empire Period. Visitors will be interested in examining the decorative designs applied to the walls and doors. They are unique since they are all made of metal. The rarest of the Institute's books will be seen in the bookcases that line the walls. Probably the most complete collection of Aeronautical Americana is here. Rare French aeronautical books are in one case. In another will be found the Hart O. Berg nine-volume collection of papers regarding the work of the Wright Brothers. There are eleven bound volumes of letters written by Octave Chanute concerning the early days of flying.

The trophies in the custody of the Institute are also exhibited in the Council Room. Visitors will see the Pulitzer Trophy, The Gordon Bennett Balloon Trophy, and the silver Edwin C. Musick Trophy awarded by New Zealand to the airman who has made the greatest contribution to overwater transport in any year. Here is also the beautiful silver urn pre-

Second floor foyer with cartoon collection.

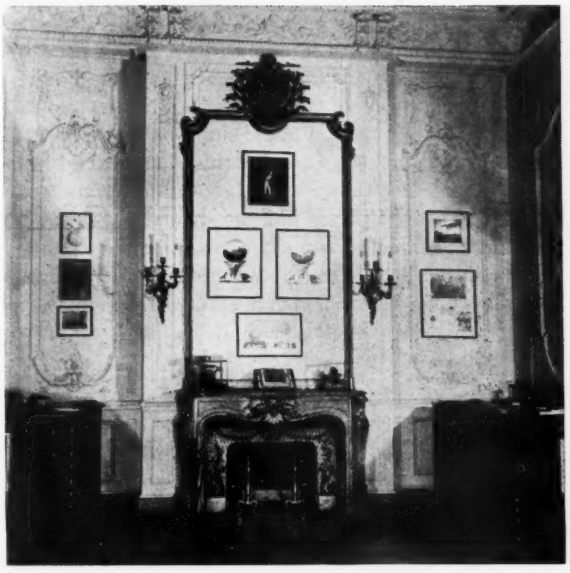
sented to the Aviation Mission, headed by Col. John H. Jouett, by the Chinese Aviation School. Six other trophies for gliding won by Henry Nicoll Wightman were presented in his memory by his parents. On the front panel are four silver plaques that were presented to winners of the James Gordon Bennett Airplane Races. Other trophies will be added from time to time.

In the small room used by the Librarian is an oil painting of the famous first ascent of the Montgolfier Balloon at Versailles near Paris. The French King and his court are witnessing the experimental demonstration of this new invention. Six reproductions of the French artist Farré may also be seen in this room.



Collection of aeronautical china and glassware.

Cabinets containing aeronautical music collection.



Bella C. Landauer print collection on walls and in cases.

The Second Floor—The Museum

A large and small elevator are available to take visitors to the other floors of the buildings. The entire plumbing of the house was newly installed and washrooms will be found on all floors except the second.

The priceless and fragile nature of the collections exhibited on the second floor make it necessary to isolate it so that it cannot be entered by unaccompanied visitors. Therefore, the elevator and service stairway doors on this floor are kept locked and members and others use the wide main stairway.

On the walls of the front room are hung that part of Captain Guggenheim's print collection which depicts the early history of man's attempts to navigate the air. These prints indicate the interest great artists of the period took in the then new sensational balloon ascents.

On two of the walls are shown portraits of the men and women who made early balloon history in the United States, France, England, Germany, and Italy. These pioneers proved that man could ascend from the earth and view its scenery from above. This fundamental urge led directly to the later development of mechanical flight.

On the other walls will be seen English, French, German, and Italian prints. For those who wish to study the engravings, etchings, and other colored prints in detail, a catalog will be available giving information about each picture.

In the four glass cases is the Institute's collection of aeronautical medals, regarded as one of the most complete in the world. All medals will be identified by cards with descriptive legends. In another glass case will be found porcelain and glass aeronautical objects of art collected by Mrs. Landauer.

In the second front room are exhibited parts of the many collections made by Mrs. Landauer, who is

recognized as one of the most discriminating and indefatigable collectors in the world. Her gifts to the Institute include what is undoubtedly the most carefully selected collection of aeronautical prints from all countries. They will be found hung on the walls and in the drawers of the cases in this room. Those interested may inspect any of these 1,511 prints upon request. Colored prints fade gradually if exposed to the light and therefore some of the rarest are not framed and exhibited on the walls. In addition to the prints are collections of fabrics, trade cards, calendars, bookplates, and Christmas cards, all having some aeronautical interest.

On the walls above the cases are the rarest prints of this collection. Examples of the art of Goya, Meryon, Daumier, Cruickshank, St. Aubin, and other world famous engravers are shown. In the glass cases may be found many interesting aeronautical relics including letters of George Washington, Thomas Jefferson, Walt Whitman, and others.

On the opposite side of the room is the unique collection of aeronautical sheet music. From practically every country in the world music memorializing epic flights and glorifying man's aspiration to fly may be found in the file cases. Some of these compositions date back to the 1780's. Others are topical and humorous. From the lithographs on the covers a complete history of aeronautics can be traced. The five early American clocks show how even the clockmakers of the middle of the last century were intrigued with ballooning.

Opposite the music is the Institute's collection of aeronautical china and glassware. A most interesting part of this collection is a set of Spode china, on each piece of which is painted an event in the history of aeronautics. It was made especially for General Maitland who was lost in the airship R-101. After his death it was purchased and brought to this country by Dr. J. C. Hunsaker. In the center case will be found more medals, principally those collected by Mrs. Landauer.

In the center foyer may be seen a collection of aeronautical cartoons from Captain Guggenheim's collection. From time to time special exhibits will be shown here. Admirers of Currier and Ives lithographs will find here the only one with an aeronautical interest. In the cases in the center of the foyer is the Institute's collection of insignia. The Italian marble fireplace is the largest and most elaborate in the house.

The collection of air-mail covers presented to the Institute by J. P. V. Heinmuller is placed in the red lacquered credenza.

The rear room was originally known as the Boucher Room because of wall murals painted by this French artist. The large center chandelier is of the finest crystal. Here is exhibited the Institute's collection of over five hundred models of airplanes. As more exhibition cases become available, the model exhibition will be better organized and displayed.

The indulgence of members and guests is asked until the exhibits on this floor can be properly shown. Only when glass and other materials are more easily obtainable and cases can be made to order will it be possible to show properly all the models owned by the Institute.

The Third Floor

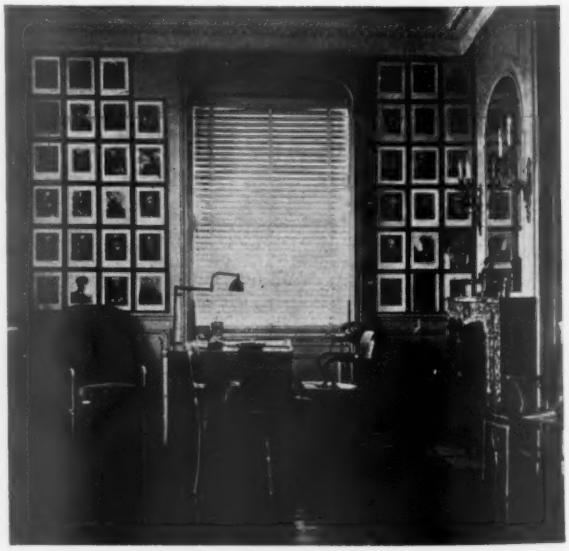
The rooms used by the officers of the Library, Archives, and the Institute are on this floor. There is also a powder room for the use of lady guests of the Institute.

On the walls will be seen etchings and engravings and water colors from Mrs. Landauer's collection. On the wall of the hallway is the architect's sketch of the building when it was built. The coupe, the ladies' long skirts, the silk-hatted gentlemen, the gas lights, and the street sweeper date the picture. It also shows the adjoining residences when Fifth Avenue was lined with beautiful mansions before tall apartments were built.

On the walls of both sides of the door to the stairway will be seen fourteen framed panels containing more of the Institute's collection of aeronautical insignia. Cloth patches, both military and commercial, are shown. The identification badges worn by the employees of aircraft factories are probably a unique collection. There is also a collection of identification badges presented by English aircraft manufacturers.

In the front room, which is used by the Director and, on occasion, by the Chairman of the Council and the President, will be seen three hundred photographs of Fellows, Officers, and Members of the Institute and others who have also made aviation history. This collection was started by Major L. D. Gardner twenty years ago and has been added to from time to time.

The murals on the walls of the halls of this and other floors of the building were presented by Mr. Grover



Director's Room, third floor.

Loening and were originally hung in the first offices of the Institute in Rockefeller Center.

Off the Director's room is a room that is a beautiful example of wood designer's art. On the ceilings of many of the rooms and over fireplaces are paintings of decorative value. The Building Committee decided to leave these paintings in place to show how art was employed in residences of the Nineties.

When the building was purchased by the Institute it was hoped that the great ornamental open staircase could be used for showing many of the framed pictures owned by the Institute. Because of the strict fire regulations now prevailing in New York City this was impossible. Therefore, many interesting pictures had to be hung in the halls of the fourth and fifth floors. Visitors are invited to inspect these floors. They show the wealth of material that the Institute has collected in its short but eventful history.

The Fourth Floor

Here are rooms used by the editorial, membership, and accounting personnel of the Institute.

The Fifth Floor

The ten rooms of this floor are occupied by the President of the Archives and the editorial staff of the Journal of the Aeronautical Sciences, the Aeronautical Engineering Review, and the Aeronautical Engineering Catalog, all three of which are published to keep members of the Institute and others abreast of the advances made in the aeronautical sciences and engineering, and industrial progress in aviation and air transport. A room is set aside on this floor as a study room and for the safekeeping of the Institute's collections of air-mail covers, air-line labels, aeronautical Christmas cards, and historical clippings, all of which may be inspected by members and others who have an interest in such specialized material.

The Sixth Floor

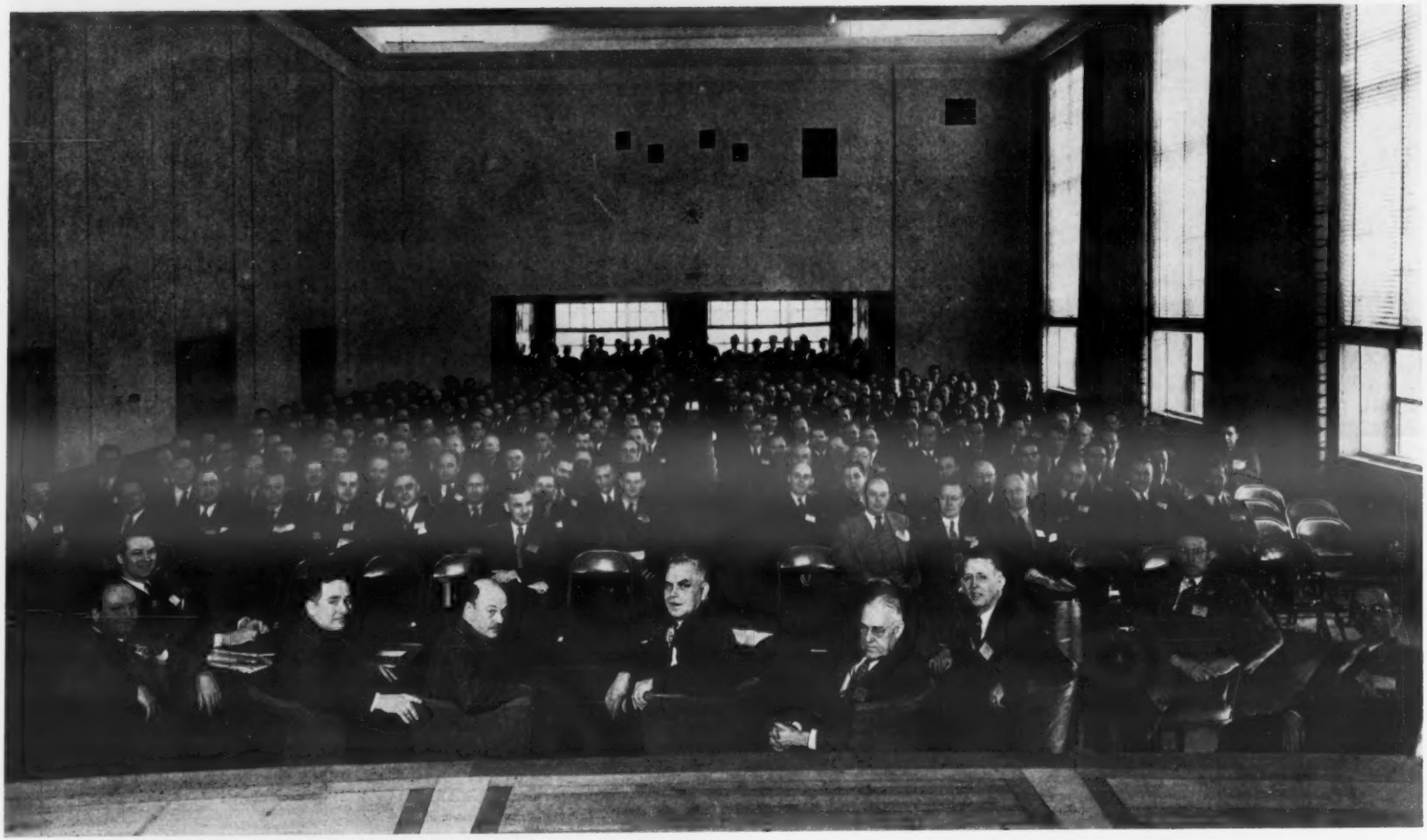
One of the six rooms on this floor is used as a rest room for the staff of the Institute. A dressing room is available for members. Large front and rear rooms provide useful space for storage.

General

The building was erected in 1896. Leading architects, decorators, and artists cooperated to make it one of the important New York mansions of that era of luxurious living. It is constructed of stone and brick, with heavy reinforcing of steel beams across every floor at intervals of five feet. All floors and walls are of tile, concrete, and hollow brick, making every room sound- and vibration-proof. The property has a frontage of thirty feet on Fifth Avenue and 120 feet on Sixth-Fourth Street and has large vault space under the sidewalks. Viewed from the exterior only five floors are to be seen. The basement, surrounded by a light areaway, is used for the library book stacks and card index and subject file cabinets. Below this floor is a subbasement with large storage space and the mechanical equipment for the three elevators and electric book service elevator and the heating and lighting services. There are eight usable floors. The house contains 49 rooms, 29 closets, and 10 washrooms. The usable space is about 19,000 square feet.

Executive Vice-President's Room.

Fireplace in the room of the Assistant to the President.



Members attending the tour of the facilities of the Aircraft Engine Research Laboratory of the National Advisory Committee for Aeronautics.

Seated at the table *(left to right)* are: Willson H. Hunter, Chief, Icing Research Division, Aircraft Engine Research Laboratory, N.A.C.A.; Bennett H. Horchler, Executive Vice-President, I.A.S.; Carlton Kemper, Executive Engineer, N.A.C.A.; J. C. Hunsaker, Chairman, N.A.C.A.; Edward R. Sharp, Manager, Aircraft Engine Research Laboratory, N.A.C.A.; Lester D. Gardner, Chairman of the Council, I.A.S.; John Victory, Executive Secretary, N.A.C.A.; Robert R. Dexter, Secretary, I.A.S.; Addison M. Rothrock, Chief, Fuels and Lubricants Division, N.A.C.A.

Institute News

National Aircraft Propulsion Meeting and Visit to N.A.C.A. Aircraft Engine Research Laboratory

The Aircraft Propulsion Meeting of the Institute was held at the Cleveland Club, Cleveland, Ohio, on Thursday, March 21. Approximately 450 members and guests registered for the three sessions of the technical meeting. On Friday, March 22, Institute members were taken on an organized tour and inspection of the facilities of the Aircraft Engine Research Laboratory of the National Advisory Committee for Aeronautics.

The first technical session was opened by Robert J. Minshall, President of Pesco Products Company. Robert S. Ames, Section Head, Research and Development Department, Goodyear Aircraft Corporation, presented a paper on "Vapor Lock and Pump Selection in Aircraft Fuel Systems." This was followed by a paper by George W. Brady, Chief Engineer, Propeller Division, Curtiss-Wright Corporation, whose subject was "Propellers for Aircraft Gas Turbines." The concluding paper of the first session was "Aircraft Ejector Performance," by Frank A. McClintock, Pratt & Whitney Aircraft Division, United Aircraft Corporation, and J. Hall Hood, Consolidated Vultee Aircraft Corporation. Following the presentation of the three papers, a discussion was held.

The second session dealt with the design and practical problems of jet engines. Robert M. Stanley, Chief Engineer, Bell Aircraft Corporation, was Chairman of the session. The following papers were presented: "Gas Turbine Power Controls," by R. Bodemuller Power Plants Laboratory, Air Matériel Command, Wright Field; "The Axial Compressor and its Aeronautical Applications," by Frank J. Gardiner, Aero and Thermodynamic Specialist, Power Plants Division, Bureau of Aeronautics, Navy Department; and "The Practical Considerations of Aircraft Gas Turbine Design," by Samuel R. Puffer, Designing Engineer, Aircraft Gas Turbine Division, General Electric Company.

Following the presentation of the final paper of the afternoon session, Lt. Col. A. B. De Yarmond, Deputy Chief of the Air Documents Division, Air Matériel Command, Wright Field, informally discussed the work of the Air Documents Division and exhibited two captured German films. One of the films was concerned with the Me 163; the second, with V-2 take-offs. Albert Arnhym gave a running commentary during the showing of the two films.

At the evening session, presided over by Abe Silverstein, Chief of the Wind Tunnel and Flight Division of the Laboratory, members of the staff of the Cleveland Laboratory of the N.A.C.A. presented four papers on the theoretic problems of jet propulsion. The subjects were: A discussion on the report "Extension of Useful Operating Range of Axial-Flow Compressors by Adjustment of Stator-Blade Angles,"

Aerial view of the Aircraft Engine Research Laboratory of the National Advisory Committee for Aeronautics, Cleveland. The adjacent Cleveland Municipal Airport is seen at the *upper left;* of particular importance among the Laboratory buildings is the Altitude Wind Tunnel *(center)* in which aircraft engine installations are subjected to trial under controlled conditions simulating those at altitude.

HANGAR FLYING

LOCKHEED

The Wreckers

If you ever want to tear a wing off an airplane, check with the men in the Structures Lab at Lockheed's Factory B-1 in Burbank. These boys are experts.

Not long ago their entire career consisted of deliberately ruining the meticulously engineered assemblies that went into the *Constellation*, just to see if the parts came up to Lockheed's exacting standards.

For instance: they took up number 61 (the first *Constellation*), blew a hole in one of the two tires on the nose landing gear, and then brought the plane in at 80 mph. The *Constellation* landed nicely.

Another time these testers purposely threw dirt and water into the oil lines of the hydraulic booster system, forcing it to work under what they understate as "adverse conditions." Adverse, that is.

They even kicked around a whole tail control assembly in a chamber that was 70 degrees below zero (Fahrenheit) until all the low-temperature bugs had been licked.

As a result of this kind of highly creative destruction, which goes on at Lockheed year in and year out, the *Constellation* is the most advanced and safest transport in service today.

L to L for L

©1946, Lockheed Aircraft Corp., Burbank, Calif.

by John T. Sinnette, Jr., Physicist, Compressor and Turbine Division; "Considerations of Inlet Designs for Supersonic Ram Jets," by De Marquis D. Wyatt, Mechanical Engineer, Wind Tunnel and Flight Division; "Analysis of Pressure Losses in Jet-Propulsion Engine Combustion Chambers," by Irving I. Pinkel, Physicist, Wind Tunnel and Flight Division; and "Dimensional Analysis of the Performance of Jet Propulsion Engines," by Newell D. Sanders, Mechanical Engineer, Wind Tunnel and Flight Division.

On Friday, March 22, Institute members assembled during the morning at the Hotel Cleveland and proceeded to the auditorium of the Laboratory. E. R. Sharp, Manager of the Laboratory, welcomed the members in a brief address. Short talks about the history and development of the Laboratory were then given by Dr. J. C. Hunsaker, Chairman, and John F. Victory, Executive Secretary, N.A.C.A.; and Carlton Kemper, Executive Engineer of the Laboratory. A. M. Rothrock, Chief of the Fuels and Lubricants Division of the Laboratory, gave an illustrated talk about the principles and application of jet propulsion. After these talks, the members were divided into groups, and each group in rotation visited the following exhibits at the Laboratory: Icing Research, I-16 Thrust Augmentation, P-59 Thrust Augmentation, New Engine Types, Fuels Research, High Temperature Alloys, Axial Flow Compressor, Surge Eliminator, Turbine Cooling, Supersonic Research, Ram Jet, and Altitude Wind Tunnel.

All groups lunched in the auditorium, where additional exhibits and demonstrations were arranged to supplement the Laboratory tour. The groups then resumed their inspections, which were concluded at 3:30 p.m.

To Those Who Contributed to the Successful Accomplishment of the Wartime Mission of the Army Air Forces

The Institute has received the following message from General Arnold who, in a brief letter of transmittal, said, "The attached statement is sent to you in the hope that you and each member of your organization, down to and including the lowest echelons, may know of my appreciation of the part you and members of your organization played in the successful accomplishments of the wartime mission of the Army Air Forces."

The wartime mission of the Army Air Forces has been successfully accomplished. In the face of tremendous odds, an innumerable host of men and women throughout the world, with inspiring loyalty, tenacious courage, and undying devotion to duty, wrested victory from the monster which the forces of oppression had carefully nurtured through decades of deception. To each and all of you who contributed to the glorious success of this wartime mission, I want now to express my deep and sincere appreciation.

You are far too many for me or for any man to name. I mention a few groups to illustrate the many into which you fall. There are, first of all, the men and women who made the supreme sacrifice, who died that men might be free. My words cannot add to their greatness nor express the deep gratitude which free men everywhere feel and shall forever feel toward them. There are, too, those who unquestioningly gave their sons and daughters to defend freedom in the far corners of the world and who added to that greatest gift their wealth and physical resources to support them in their fight. There are the training agencies, civilian and military, who taught these sons and daughters of America the many and intricate skills which enabled them to become the greatest striking force the world has seen. There are the scientists, the industrialists, and the worker who conceived, designed, and produced the myriad weapons and other necessities without which such a force would have been helpless. There are the civilian agencies who cooperated in the active mission of the A.A.F.—the air-lines organizations who ferried aircraft, men, and material across hitherto uncharted routes, the Civil Air Patrol, who assisted in patroling the coast of the homeland, and a host of others. There are people of the many other nations, such as the Chinese who defied his Japanese conqueror by carrying the crashed Doolittle flier to safety and the Frenchman who, in like manner, defied the German. There are the sister services of our Allies, freedom-loving men of many nations and many tongues who stood with us in the dark hours and who gladly shared with us all they had. There are the brothers in arms of our own nation, the U.S. Navy and the other components of the Army of the United States, who rendered us every possible service at every opportunity. Finally, there are the men and women of the great Army Air Forces family. My feeling toward you, you well know. You have acquitted yourself well; I am proud to have been your commander.

I add my commendation and thanks to those of freedom-loving people everywhere and transmit them with pleasure to all who contributed to the successful accomplishment of the wartime mission of the Army Air Forces. We have met the challenge of the foes of freedom and, in history's greatest demonstration of brotherly cooperation, preserved the right of the common man to be free.

Our mission now is to cooperate in the same manner to build up industrial and economic peacetime America and to guarantee the future peace of the world. It is not an easy assignment. There will be difficult problems to face, hard decisions to make, burdensome tasks to accomplish. There will be little applause. I know the character of the men and women of the Army Air Forces, of the men and women at whose sides we fought and of those who made us industrially the arsenal of the world. I am confident that we will be able to solve our peacetime problems as effectively as we solved those of the war period.

Signed.....H. H. ARNOLD
Commanding General, Army Air Forces

I.A.S. Members Appointed Airport Commissioners

Capt. Harry F. Guggenheim, President of the Daniel Guggenheim Fund for the Promotion of Aeronautics, Lt. Gen. James H. Doolittle, Vice-President of Shell Union Oil Corporation, and Lt. Laurance S. Rockefeller, a Director of Eastern Air Lines, Inc., all members of the Institute, have been named by Mayor O'Dwyer as commissioners of the newly created New York City Airport Authority. Captain Guggenheim will serve as Chairman. The three-man commission is charged with setting up the authority that will develop, operate, and maintain the city's air terminals—La Guardia Field and Idlewild Airport.

Franklin Institute Honors I.A.S. Members

Three Institute members have been chosen by The Franklin Institute to receive awards for outstanding scientific contributions to aeronautics.

Dr. Sanford A. Moss, Consulting Engineer in the Supercharger Engineering Division, General Electric Company, and a Fellow of the Institute, has been designated to receive the Potts Medal "in consideration of the extreme value of his work in making a turbosupercharger a successful and reliable part of an internal-combustion engine." For this work, Dr. Moss received The Sylvanus Albert Reed Award for 1943 and the Holley Medal of the American Society of Mechanical Engineers, and in 1940 he was awarded the Collier Aviation Trophy jointly with the U.S. Army Air Forces.

Sir Henry Thomas Tizard, President of Magdalen College, Oxford University, and a Fellow of the Institute, will receive the Franklin Medal "for his outstanding contributions which have advanced the science of aeronautics in the fields of full-scale flight-test procedure and internal-combustion engines relating to fuel economy."

Lewis A. Rodert, Research Engineer at the Stewart-Warner Corporation, and a Member of the Institute, has been chosen to receive the John Price Wetherill Medal "in consideration of his important and applied work in developing a thermal ice-prevention system for airplanes."

Gifts to the Aeronautical Archives

Lt. Gen. and Mrs. James H. Doolittle gave a model of the North American B-25 Mitchell bomber, adding to their previous generous gifts. Models of the F6F, F7F, and F8F carrier-based fighter airplanes were given by the Grumman Aircraft Engineering Corporation in addition to a set of color prints of Grumman airplanes. A model of the TBF Avenger was also loaned by that company. An exhibition case for the display of models was given by the New York Museum of Science and Industry through the courtesy of Robert Shaw.

Capt. Harry F. Guggenheim.

W. A. M. Burden added 403 aeronautical periodicals and 19 reports of the National Advisory Committee for Aeronautics to his previous generous gifts. *Aero Digest* gave 120 foreign and domestic aeronautical periodicals, adding to its previous gifts. Van Wyck Hewlett added 87 publications of the National Advisory Committee for Aeronautics and two books to his previous gifts. Dr. Alexander Klemin added photographs, books, clippings, and reports to his previous large gifts. A rubberized silk map of Italy which he carried in flight over Italy during the war was given by Major G. H. Robinson. The Detroit Public Library gave 200 photographs of airplanes, persons, and aeronautical events of the first World War and the decade following it.

Dr. Eugene F. Du Bois gave 13 aero medical publications. Robert Mountsier sent 250 issues of aeronautical periodicals. More than 450 issues of aeronautical periodicals and house organs were received from Aero Insurance Underwriters, Inc., adding to its previous generous gifts.

Documents relating to applications before the Civil Aeronautics Board for new air routes and extensions of existing air routes were received from Braniff Airways, Inc.; Eastern Air Lines, Inc.; Southwest Airways Company; Transcontinental & Western Air, Inc.; and United Air Lines, Inc.

Additional gifts were received from Aircraft Radio Corporation; Burnham and Company; Delafield & Delafield; Douglas Aircraft Company, Inc.; Emanuel and Company; Future Springfield, Inc. (Massachusetts); Kobbe, Gearhart & Company, Inc.; the National Aeronautic Association; Walter W. Ristow; the Sea-Air Committee of the National Federation of American Shipping, Inc.; the Civil Aeronautics Administration; the Civil Aeronautics Board; the Office of War Information; the Post Office Department; the State Department; and the U.S. Weather Bureau.

Corporate Members Expand

Breeze Corporations, Inc., has purchased in a cash transaction the Anderson Stove Company, Inc., and Foundry Service, Inc., both of Anderson, Ind. The Anderson company manufactures a kitchen gas range that operates on a sealed-heat principle and will use sheet metal processed by the Breeze company and castings produced by Foundry Service, Inc.

These acquisitions mark the first venture of the Breeze company into the household-appliance field. The company will continue the manufacture of aeronautical accessories.

Lockheed Aircraft Corporation has resumed the operations of the Lockheed Aircraft Corporation of Canada, Ltd., which was formed in 1939 but remained inactive during the war. The Canadian office has acquired 60,000 sq.ft. of warehouse space from Fleet Aircraft, Ltd., in Fort Erie, Ontario, for its spare-parts department. It will supply spare parts for Lockheed airplanes in use in the Royal Canadian Air Force and in Canadian air lines. Robert E. Gross, President and Chairman of the Board, and Carl B. Squier, Vice-President of Lockheed Aircraft Corporation, are President and Vice-President, respectively, of Lockheed Aircraft Corporation of Canada, Ltd.

Minneapolis-Honeywell Regulator Company has purchased a new plant from Small Electric Motors Ltd. (Canada), located in the outskirts of Toronto. The factory was built at the beginning of the war for the production of gun sights and other fire-control instruments for the Canadian, British, and American navies. It has been purchased complete with machine tools that have been adapted to the manufacture of the parent company's line of heating, ventilating, and air-conditioning control instruments.

The new plant will make and assemble the major share of Minneapolis-Honeywell's controls for the Canadian market. In addition, it will house sales and executive offices and serve as headquarters for the Canadian operations.

Wright Aeronautical Corporation has received the approval of the War Assets Corporation for the purchase of the Wood-Ridge, N.J., plant used by the Wright company during the war for the manufacture of Wright Cyclone engines. The 35-acre plant, comprising more than 1,000,000 sq.ft. of floor space in the present manufacturing, assembly, and test areas, was built in 1942. It is planned to house all departments of the company at the new plant, facilitating the consolidation of manufacturing and office facilities that were formerly located in four plants in the Paterson, N.J., area.

Sections and Branches

Detroit Section

On March 27 a joint meeting of the Detroit Section of the Institute and the Engineering Society of Detroit was held in the Horace H. Rackham Educational Memorial Building, with an attendance of 750. B. A. Denicke, Acting Technical Assistant to the Director, Air Navigation Facility Operations Service, C.A.A., spoke on "Application of Radar to Air Traffic Control," and Harold R. Harris, Vice-President and General Manager, American Overseas Airlines, Inc., gave a talk on "The Shape of Things to Come in Air Transportation."

Mr. Denicke in his talk gave an analysis of radar and radio in the device known as G.C.A., or Ground Control Approach. By this system, aircraft may be landed during poor visibility conditions without any special equipment on the aircraft other than its conventional radio. By the use of radar instrumentation, operators on the ground know the exact location of the aircraft and can give the pilot instructions by radio to enable him to land accurately. The talk was supplemented by an A.A.F. sound film which illustrated the operation of G.C.A.

Mr. Harris discussed the transoceanic accomplishments of air travel and some of today's problems and requirements in aviation. He made a number of predictions for the future, intended to cover the next 5 years. Among these were the statements that cruising speeds will not exceed 350 m.p.h.; that transportation between airport and civic center will become more rapid, and that helicopters will not yet be used for this purpose; that comfort on longer air trips will increase; that air-borne radar to avoid collision is not probable; that jet propulsion is not likely to be used for commercial purposes for economic reasons; and that airport runways will not exceed 7,500 ft., and may become shorter. According to Mr. Harris, standees, or "strap-hangers," on crowded airplanes may be the key to low-fare air travel. He stated that most passengers would not object to this because of the reduction in fare which it would allow.

Los Angeles Section

A dinner meeting was held on March 1 under the chairmanship of C. L. Johnson, who opened the meeting with a report to the members on the progress of the building plans. He pointed out that in about 6 weeks the plans would be sufficiently advanced to ask for bids from contractors and that it is planned to start building as soon as possible after the selection of the successful bidder.

The meeting was then turned over to L. E. Root, Program Committee Chairman, who introduced Arthur E. Raymond, President of the Institute.

Harold R. Harris.

Mr. Raymond announced that Capt. S. Paul Johnston, U.S.N.R., would join the Institute as Director. He also reported that at the Annual Business Meeting in New York the Council had approved a proposal that 50 per cent of the local corporate and member dues be allocated to the Los Angeles Section to defray operating expenses of the building after it is completed.

Mr. Raymond introduced Smith J. DeFrance, Engineer in Charge, Ames Aeronautical Laboratory, who spoke on the subject "N.A.C.A. Research and Testing Facilities in 1946." Mr. DeFrance outlined the N.A.C.A. basic research program, its present and proposed testing facilities, and the means provided for future cooperation between the N.A.C.A. and industry. At the conclusion of the talk, a discussion ensued on the various problems of industry as related to the N.A.C.A.

Miami Section

On February 20 a meeting was held at the Miami Country Club, under the chairmanship of B. C. Stephens. It was decided that a membership campaign be launched, to include all air lines and private aircraft enterprises in Miami and the surrounding territory, and including both maintenance and technical personnel. It was also agreed that a dinner be held in conjunction with each meeting.

The principal speaker of the meeting was Capt. Horace Brock, Chief Pilot of the Latin-American Division of Pan American Airways System, whose subject was "Night Flying Technique in the Tropics." The speaker stated that in the 1920's domestic air lines used beacons for night flying. These were spaced along the airways with flashing signals on right or left of the route, but this limited night flying to contact only. In the 1930's the radio ranges were installed. For flying over water, however, celestial navigation was the only means of guidance, and bad weather would cause night flights to be cancelled. In addition, large formations of Cb (cumulonimbus) clouds were encountered along the equator. But not until the crossing of the Atlantic from Natal to Dakar was the full force of the equatorial Cb's experienced, according to Captain Brock. Many a pilot found new experiences flying through the static charges that formed a wall of flame along this route. The tremendous heights of these clouds prevented flying over them and flying under them resulted in low altitude and bad weather conditions. Night landings in congested harbors were also a factor that required a shift to daylight arrival and departure. In conclusion, the speaker stated that out of the war have come faster aircraft with higher wing loading, which tends to stabilize the aircraft in rough weather of this type, and that with new instruments, blind-flying facilities, and coordination with foreign countries, a system for overwater flying can be developed to compare with that of present domestic routes.

At a meeting held on March 19, Howard Crothers, Service Representative of Vickers, Inc., spoke on the subject "Vickers Aircraft Hydraulic Equipment." Mr. Crothers compared the Vickers new-type rotary pump with the old-type gear pump to show the higher degree of efficiency of the new type. According to the speaker, the reason for this was the excess clearance between the gears and the housing. As the gears and the housing expanded some metal was possibly ground away in this area, a condition that invited leakage, thus lowering the operating efficiency and pressure.

The new pump is called the Vickers Axial Piston Type Constant Displacement Pump and is for operating pressures up to and including 3,000 lbs. per sq.in. Mr. Crothers stated that the volumetric and overall efficiency is high and there is no appreciable increase in slippage as the pressure is increased. The maximum recommended speed is 3,750 r.p.m. at which the output is 13.3 hp. for the Model PF-3911 Series. The weight of this pump is only 6.8 lbs., providing the weight-to-power ratio of only 0.51 lb. per hp.

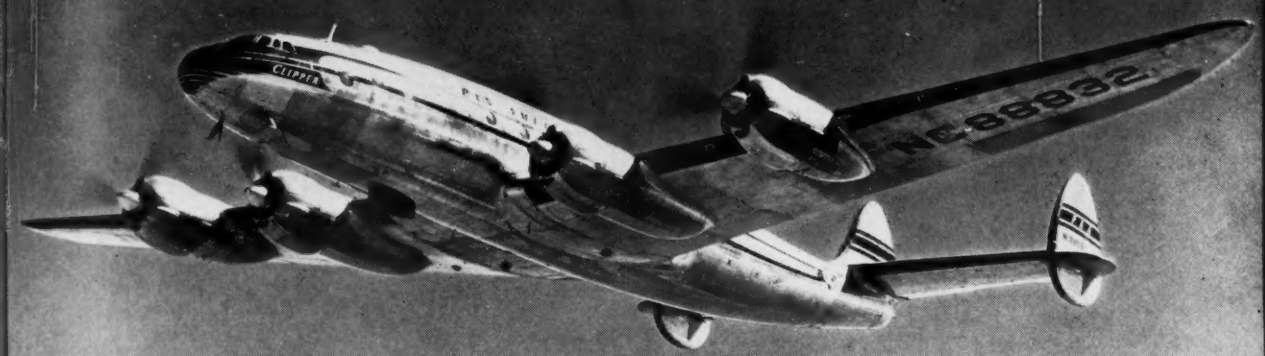
A showing of the color film *Alaska* followed the talk.

New York Section

A meeting was held on March 18 in the McGraw-Hill Building Auditorium, which was attended by 200 members and guests. Chairman Jerome Lederer presided. Willy Ley, Research Engineer at the Washington Institute of Technology, spoke on "The Present Status of the Conception of Space Travel." Mr. Ley was formerly asso-

"CONNIE"

A QUEEN OF THE AIRWAYS



THE LOCKHEED CONSTELLATION

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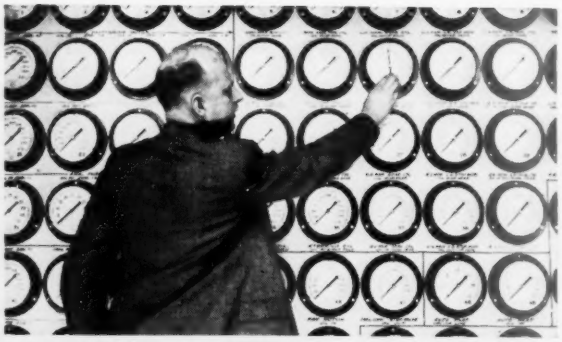
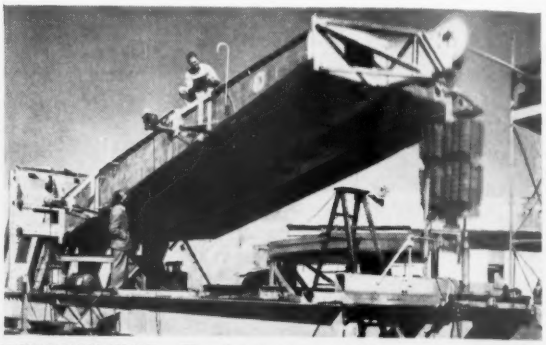
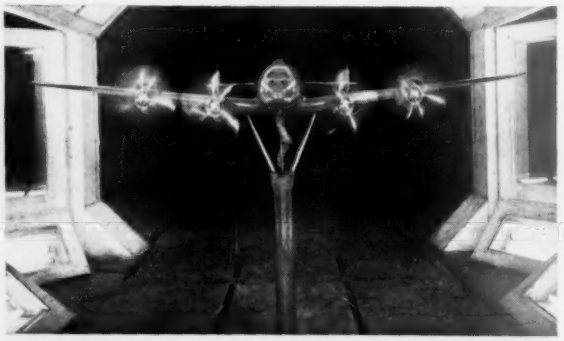
PREFLIGHT TESTING SHOWED "CONNIES" ROYAL MONTHS OF ARMY



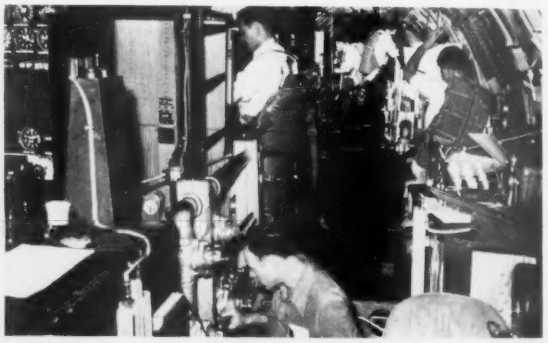
CONTROL BOARD—On this master control board, Lockheed experimental engineers watch every phase of "Connie's" preflight testing.



VIBRATION TEST—To check the sturdiness of "Connie's" 3,500 lb. wing, it was shaken for hundreds of hours—subjected to test loads up to 50 tons.



WIND TUNNEL TEST—A 9-foot wing span model of "Connie" helped designers to predict her flight characteristics before she ever left the ground.



LAB SHIP—The Constellation's engineering developments were subjected to exhausting tests in lab ships before they were installed.

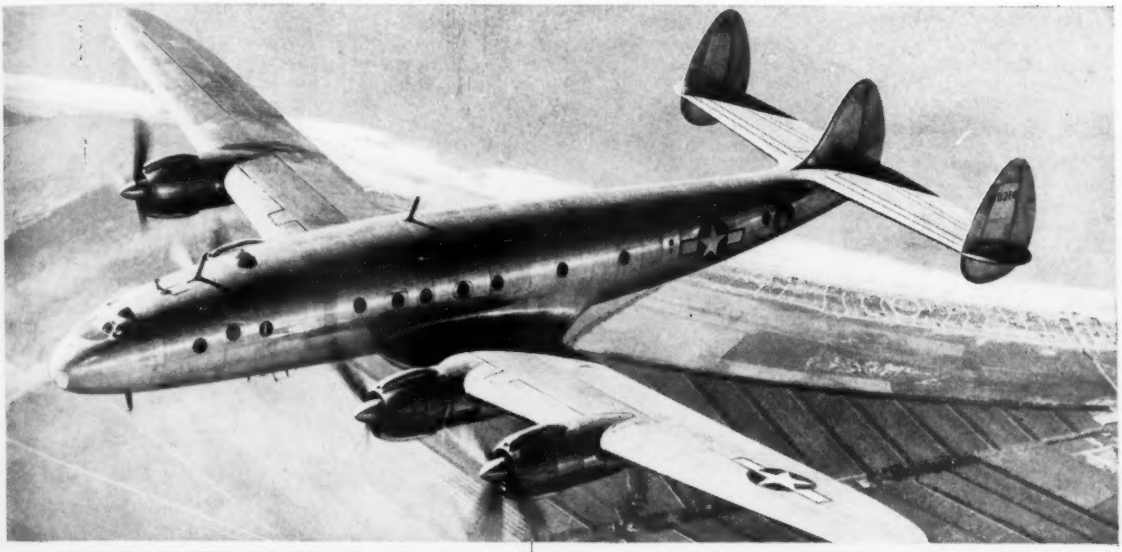
LOW TEMPERATURE TEST—To make certain "Connie's" operating units would perform in searing heat or Arctic cold, they were first tested in this temperature chamber.

HYDRAULIC FATIGUE TESTS—Full scale mockup simulated the most drastic flight conditions. "Connie's" hydraulic system was tested and tested again.

UNITED STATES

BLOOD BEFORE SHE EVER LEFT THE GROUND!

SERVICE PROVED IT!



"CONNIE" IN THE AIR FORCES—"Connie" established new standards of dependable performance and economical operation in her three years with the Army Air Transport Command. Taking off and landing all over the world, on lighter, stronger U. S. Royal Airplane Tires, she performed vigorous service faster and better than ever before.

"CONNIE" IN AIR LINE SERVICE—Flying for many of the world's great airlines, "Connie" is now breaking speed and performance records on commercial airline routes everywhere. Blending speed and luxury with range to span oceans, Lockheed Constellations are tying cities and nations closer together—shrinking barriers of time and distance.

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ciated with the German Rocket Society and is the author of many books and articles on rockets. He stated that the problem of space travel is not purely one of engineering, but that it has its astronomic and biologic aspects as well. Through astronomic research, certain knowledge has been, and is being, established about the other planets. Biologic research studied the effects of vacuum and cold.

According to Mr. Ley, a space ship cannot "fly" to the moon, since the medium in which it must travel is not suitable for flying; instead, it must be "fired," and that it propels itself from then on. By a series of equations, the speaker then showed what are considered the feasible requirements for a journey to the moon.

Concerning the danger of the rocket's colliding with meteors en route, Mr. Ley stated that the possibilities are almost negligible and that the rocket would normally continue without collision until it struck the moon. According to the speaker, by the use of a white powder in the nose of the rocket, with a small explosive charge, the powder scattering upon impact could be seen through a telescope and would establish that contact had been made.

A discussion period followed the address.

Philadelphia Section

A meeting of officers and committee chairmen held on March 25 was devoted to a discussion of methods by which a larger member attendance at Section meetings could be achieved. It was suggested that each meeting should consist of a dinner, the presentation of a paper, and a motion picture showing. It was also proposed that the papers presented at technical meetings should be given by well-known speakers from other cities, as well as by local engineers. A vote indicated a preference for a schedule of six or seven meetings during the year.

At a meeting held on March 26, Seymour Gottlieb, Aeronautical Engineer at the Naval Air Experimental Station, U.S. Naval Base, Philadelphia, presented a paper titled "Techniques of Static Tests." Mr. Gottlieb explained the various methods of loading, such as dead weights, formers and hydraulic loading, and tension pads and hydraulic loading. He discussed load-measuring devices, with special emphasis on the "C-100P" type dynamometer specially designed by the Naval Air Experimental Station. He also explained the various techniques of obtaining deflections and the technique of conducting combined static and dynamic tests. Motion pictures of the static test of a Navy XLRA-1 glider and special wing static tests for the TBF-1 as performed by the Naval Air Experimental Station were exhibited by the speaker.

Wichita Section

On March 22 a meeting was held at the Broadview Hotel under the chairmanship of W. E. Burnham. The Advisory Committee, composed of Penrose S. Albright, W. E. Burnham, Kenneth Razak, R. W. Allred, Wilfred Pearce, and Tom Salter is being carried over from last year. R. W. Allred was appointed temporary Treasurer, replacing Herbert Kueck, who has left Wichita. Ernest G. Stout, Design Specialist in Charge of Hydrodynamics, Consolidated Vultee Aircraft Corporation, spoke on the subject "Radio Controlled Dynamic Models." The speaker discussed the means of obtaining accurate water-handling characteristics of flying boats by building dynamic models of proposed hull forms and controlling them by radio on water-test runs. According to Mr. Stout, the results agreed with data obtained from full-scale tests.

Carnegie Institute of Technology

Allen H. Blaisdell, Associate Professor of Mechanical Engineering, has replaced Leroy Olsen as Faculty Adviser of the Carnegie Institute of Technology Student Branch. Mr. Olsen is on leave of absence.

Catholic University of America

At a meeting held on March 19, Lt. Comdr. Frank Plattner gave a talk titled "Recent Developments in the Navy." The films *Cyclone Combustion* and *Air Flow and Air Flow Separation* were shown. Chairman Michael J. Quirk presided.

Georgia School of Technology

At a meeting held on February 14 the following officers were elected: Charles Green, Chairman; Le Roy Day, Vice-Chairman; T. A. Vogel, Secretary; and Robert R. Stephens, Treasurer.

University of Illinois

A combined technical and business meeting, attended by 250 members and guests, was held on March 21 in the Electrical Engineering Laboratory, under the chairmanship of Leland C. Schubert. A Membership Committee and a Meetings and Papers Committee were appointed. Robert Beckmann, of the Allison Division of General Motors Corporation, spoke on the subject "Jet Propulsion." The talk was illustrated with slides.

Massachusetts Institute of Technology

At a meeting held on March 5, the new officers of the Branch were introduced to the members. Chairman Melvin B. Zisfein presided.

On March 15, 22 members of the Branch made a tour of the plants of the Sikorsky Aircraft and Chance Vought Aircraft Divisions of United Aircraft Corporation at Bridgeport, Conn.

University of Oklahoma

On March 12 a meeting was held in the Engineering Building under the Chairmanship of Don Malvern. R. V. James, Faculty Adviser, spoke on the articles which appeared in the February issue of the JOURNAL OF THE AERONAUTICAL SCIENCES. The film *The Production of the Bell Airacobra* was shown.

Rensselaer Polytechnic Institute

The following officers were elected to the Student Branch at Rensselaer Poly-

Sherman Fairchild Publication Fund

Many papers presented at meetings of the Institute or submitted for publication to the *Journal of the Aeronautical Sciences* or *Aeronautical Engineering Review* are so specialized that publication and widespread distribution are not economical or, in some cases, desirable.

The Sherman Fairchild Publication Fund, endowed by Mr. Fairchild, will, in the future, consider sponsoring the publication and distribution, without charge, of such specialized papers.

One of the first papers to be published under the auspices of the Fund will be an article on "Consolidated Vultee's New Aeronautical Laboratory," written by Mr. Jack Mason, Project Engineer of the Aeronautical Laboratory's Development Engineering Department. The paper is a complete illustrated description of the Laboratory.

This publication will be ready for distribution in the latter part of June and will be sent without charge to members requesting it. It will be available to nonmembers of the Institute at 25c per copy.

As the print order of the article will be determined by the number of requests received, members and others are urged to send in their requests without delay.

technic Institute: Arthur S. L. Ahlin, Chairman; Newton C. Garland, Secretary; and Robert G. Loewy, Treasurer. Prof. A. J. Fairbanks is Faculty Adviser.

At the March 14 business meeting Arthur Ahlin, Branch Chairman, and Prof. A. J. Fairbanks, Faculty Adviser, explained the organization of the Institute and outlined the advantages to be derived from membership. Professor Fairbanks also presented a tentative program for the remaining meetings of the semester. After the business meeting, the film *Clippers at War* was shown.

At a technical meeting held on March 28, J. W. Miller, Instructor of Aeronautical Engineering at R.P.I., gave a talk on the technical papers presented at the National Aircraft Propulsion Meeting in Cleveland on March 21, and described the tour of the Aircraft Engine Research Laboratory of the N.A.C.A., held on the following day. He described the apparatus in use and the various types of power plants being tested.

Agricultural and Mechanical College of Texas

The film *Historical Flights of the 1930 Era* was shown at a meeting held on February 12. Vice-Chairman Robert M. Fleming presided.

Tri-State College

At a meeting held on February 4, Chairman Walter Remy spoke on the subject "Jet Propulsion."

Newly elected officers for the spring quarter are Joseph Sveda, Chairman; Richard S. Peterson, Vice-Chairman; and Vern D. Shipley, Secretary-Treasurer. Prof. Vern Jones is Faculty Adviser.

News of Members

Alfred Africano is now a Senior Project Engineer with the Curtiss-Wright Corporation.

John D. Ahlers has become Chief of the Aircraft Branch, Operations Division, Foreign Liquidation Commission, in its Rio de Janeiro office.

Horace J. Alter has joined Consolidated Vultee Aircraft Corporation as a Design Engineer—Preliminary Design.

George K. Anderson has become a Mechanical Designer in the Heavy Machine Division of York Research Corporation.

Seymour M. Arkawy is now President of Cortlandt Construction Corporation.

Irving L. Ashkenas has joined Northrop Aircraft, Inc., as Supervisor of Aerodynamics Section.

Joseph J. Bartnick has become a Senior Stress Analyst at The Glenn L. Martin Company.

John T. Bennett is now a Structural Design Engineer at Northrop Aircraft, Inc.

Irving Berler has joined Republic Aviation Corporation as a Wind Tunnel Engineer.

Lucius R. Boley is now an Engineer with J. W. Ryan Construction Company.

Francis J. Borofka has joined The Glenn L. Martin Company as a Layout Draftsman.

Arthur A. Butterworth is now engaged in Development Engineering in the Magnesium Division of Dow Chemical Company.

Charles E. Chapel has become Director of Research and Development at Northrop Aeronautical Institute Division of Northrop Aircraft, Inc.

Bernard N. Charles is now an Engineer in the Accommodations Group at American Airlines, Inc.

John M. Coan, Assistant Professor of Aeronautical Engineering at Iowa State College, has become a Research Engineer at the Santa Monica Plant of Douglas Aircraft Company, Inc., for the spring and summer academic terms.

Sidney Cornell has joined Woods Hole Oceanographic Institution as a Research Associate.

Francis L. Cramer has become an Engineer at Megquier and Jones Company.

Eugene S. Davidson is now a Sales Engineer with the Davidson Industrial Contracting Company.

Horace C. Davis has become a Senior Flight Test Engineer at The Glenn L. Martin Company.

Jefferson D. Davis has joined Allen Artcraft, Inc., as an Engineer.

George G. Downing is now a Senior Design Engineer at Fredric Flader, Inc.

B. Allison Gillies has been appointed to the Non-Scheduled Flying Advisory Committee of the Civil Aeronautics Administration to represent the interests of private fliers and nonscheduled operators in the Sixth C.A.A. Region.

Jean H. Du Buque has been appointed Advertising and Public Relations Director of Lear, Incorporated.

Wilbur L. Ebeling has joined the firm of Smith, Hirchman and Grylls as a Mechanical Engineer.

Michael H. Froelich has become Assistant Publisher of *Flying* magazine.

Martin Goland is now Chairman of Applied Mechanics Research at Midwest Research Institute.

Robert L. Goodin has joined Pratt & Whitney Aircraft Division of United Aircraft Corporation as Experimental Test Engineer.

Edward R. Goodlett is now Superintendent of Structures with Transcontinental & Western Air, Inc.

Haskell R. Gordon has become Manager of Standard Paint Company, Inc.

Alex Gorfin is now President of Alfa Instruments, Inc.

Marvin H. Greenwood has become Vice-President of the firm of Anderson, Greenwood and Company.

Robert J. Grenzeback has joined the Barber-Colman Company as Development Engineer.

Major Raymond H. Hajek is now in charge of the Flight Projects Branch of Operations at Headquarters, Air Transport Command, Washington, D.C.

Dale B. Hamilton has joined the P-V Engineering Forum, Inc., as a Design Engineer.

Max E. Hartley is now part owner and Engineer in the firm of Pacific Flyers, Inc.

Akira Hasegawa has returned to the Regional Planning Commission (Los Angeles) as an Engineering Draftsman.

Joel T. Henry has formed the engineering firm of Henry & Hutchinson, Inc.

Shukry K. Ibrahim is now engaged in research work at the City and Guilds College of the Imperial College of Science and Technology (London).

Walter H. Johnson has joined the Chance Vought Aircraft Division of United Aircraft Corporation as an Aerodynamicist.

Felix Kallis, formerly Chief Process Engineer at the Continental-Denver Modification Center of Continental Airlines, Inc., has joined Ryan Aeronautical Company as Power Plant Design Engineer.

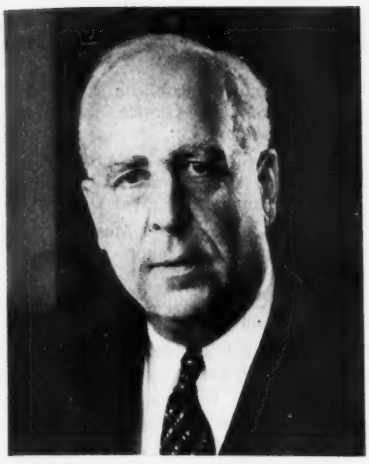
Charles H. Kaman has become President and Chief Engineer of the Kaman Aircraft Corporation.

James P. Kearns, Jr., is now a Wind Tunnel Engineer in the Lone Star Laboratory Division of Consolidated Vultee Aircraft Corporation.

Lt. Col. William H. Klenke has returned from active duty with the U.S. Marine Corps and has become New York Manager of Consolidated Vultee Aircraft Corporation.

Eugene J. Korda is now Chief Designer in the firm of Korda Graphics.

William G. Kulesz has joined Mine Safety Appliance Company as Sales Engineer.



Paul W. Litchfield has been re-elected Chairman of the Board of Directors of the Goodyear Tire & Rubber Company.

Henry T. Lathrop has become Assistant Superintendent at the Bissell Carpet Sweeper Company.

Lloyd H. Leonard is now Chief Engineer at Thomson Industries, Inc.

Norman Lesk has joined the Sperry Gyroscope Company, Inc., as a Designer.

Arnold Levine is now a Liaison Engineer at Kellett Aircraft Corporation.

Robert W. Lilligren has become a Flight Service Engineer at Douglas Aircraft Company, Inc.

Herbert F. Miller is now employed in a mechanical capacity at Servair, Inc.

Harold P. Moon has become President of Metropolitan Aviation Corporation.

Felix Nagel, formerly Chief Engineer at the Aircraft Development Corporation, has become Chief Engineer of the Aircraft Division of the Engineering and Research Corporation.

Henry J. E. Reid, Engineer in Charge, Langley Memorial Aeronautical Laboratory of the National Advisory Committee for Aeronautics, has been awarded the Honorary Degree of Doctor of Engineering by Worcester Polytechnic Institute in recognition of his work in the design and operation of wind tunnels and flight-research instruments.

Eugene W. Norris, formerly Manager of the Technical Department of the Aircraft Industries Association of America, Inc., is now Chief Engineer at Luscombe Airplane Corporation.

Yves Nubar has joined Republic Aviation Corporation as a Development Engineer.

Lt. Comdr. Leslie R. Parkinson, U.S.N.R., has been appointed Professor of Aeronautical Engineering in the College of Applied Science, Syracuse University.

Jordan Perlin is now a Research Engineer at Republic Aviation Corporation.

William D. Plommer has joined Edo Aircraft Corporation as a Structural Designer.

Casimer Porowski is now with the Turbine Engineering Department of General Electric Company.

Charles A. Potter has joined Wright Aeronautical Corporation as Air-Line Consultant.

Bruno C. Reciputi is now on the sales staff of the Hydraulics Division of the Saval Company.

Jere H. Roach is now Plant Engineer at the Penn Brass & Copper Company.

Robert Rosenbaum has joined Republic Aviation Corporation as Senior Research Engineer, in charge of the Research Department in the New York City office.

Albert J. Rosenberg is now Visual Aids Editor and Technical Editor at McGraw-Hill Publishing Company.

Wladyslaw Sandowski has become Plant Engineer at the Metal & Thermit Corporation.

Robert H. Scanlan has joined Republic Aviation Corporation as Senior Research Engineer.

Iven L. Schlegel is now a Layout Draftsman at A. V. Roe & Company, Ltd. (Canada).

John E. Schuler has joined Consolidated Vultee Aircraft Corporation as an Aerodynamicist.

Milton M. Schwartz has become a Designer with the firm of Laurance Schwall & Associates.

John W. Shaver is now a Production Design Engineer, Project Group, at the El Segundo Plant of Douglas Aircraft Company, Inc.

Kenneth E. Smith has joined Consolidated Vultee Aircraft Corporation as a Project Engineer.

Herman B. Spiegel has become a Senior Designer at Philco Products, Inc.

Edward W. Strong is now an Engineer in the Special Missiles Group at North American Aviation, Inc.

Asher Tischler is taking the course in Mechanical Engineering at Lafayette College.

Milan A. Tomanik has joined the Aircraft Gas Turbine Division of De Laval Steam Turbine Company as a Layout Draftsman.

Dean F. Triplett is now Operations Manager of U.S. Flying Services.

Edwin W. Walker has joined The Glenn L. Martin Company as a Project Engineer.

John J. Wallace is proprietor of the firm of John J. Wallace.

Leslie W. Westerling has joined the faculty of Spartan College of Aeronautical Engineering as Associate Professor of Advanced Airplane Design.

Jack V. Whipple has become a partner in the firm of Whipple and Rattray.

Melvin E. Williamson is now Radio Director of Raymond R. Morgan Company.

Thomas Wolfe, formerly Vice-President in Charge of Traffic, Advertising, and Public Relations at Western Air Lines, Inc., has opened an aviation research office in Los Angeles.

Glenn E. Wright has become an independent Management Consultant.

Thomas J. Zilka has joined the faculty of Montana State College as Assistant Professor of Mechanical Engineering.

Members Elected

The following applicants for membership or applicants for change of previous grades have been admitted since the publication of the list in the last issue of the REVIEW.

Transferred to Associate Fellow Grade

Brie, Reginald Alfred Charles, The Fairey Aviation Company, Ltd.

Hajek, Raymond Rowland, Major, Flight Projects Branch of Operations in Headquarters, Air Transport Command, U.S. Army Air Forces.

Kraft, Hans, Dipl. Ing., Aerodynamic Consultant, General Electric Co.

Lundberg, Bo Klas Oskar, Chief of the Structural Dept., Aeronautical Research Institute of Sweden (Sweden).

Elected to MEMBER Grade

Allardt, Frederick Hamilton, M.Sc.; Engineer, Douglas Aircraft Co., Inc.

Burns, Francis Stanton, Major Engineer, Boeing Aircraft Co.

Clarkson, Christopher, Intava, Inc.

Collins, George Joseph, Jr., B.S. in M.E.; Associate A.M. Instructor, U.S. War Dept.

Fink, Frank Wolfe, B.S. in M.E.; Chief Engineer, Consolidated Vultee Aircraft Corp.

I.A.S. National Meeting Schedule

Light Aircraft Meeting

June 13–14, 1946

Detroit, Michigan — Horace H. Rackham Educational Memorial

Annual Summer Meeting

July 18–19, 1946

Los Angeles, California — Royce Hall, U.C.L.A.

Air Transport Meeting

October 24, 1946

Washington, D.C. — Hotel Statler

Tenth Wright Brothers Lecture

December 17, 1946

New York, N.Y. — (Location to be announced)

Fifteenth Annual Meeting

January 28–29–30, 1947

New York, N.Y. — (Location to be announced)

The Meetings Committee of the Institute invites participation in the technical sessions of the Air Transport and Fifteenth Annual meetings of the Institute. The programs of the Light Aircraft and Annual Summer meetings are in process of completion and additional papers cannot be considered.

Members or organizations wishing to submit papers for these eetings should send complete papers, or outlines or summaries, to the Meetings Committee at least three months prior to the meeting at which it is proposed to present the paper. Outlines or summaries should not exceed 1,000 words.

All papers submitted will be considered for publication in the *Journal of the Aeronautical Sciences* or the *Aeronautical Engineering Review*.

All correspondence should be addressed to

The Meetings Committee

Institute of the Aeronautical Sciences

2 East 64th Street

New York 21, N.Y.

Hasselbring, Bernhart H., A.B.; Chief, Tool Design Dept., Engineering and Research Corp.

Hoag, Lyndsey Jacob, B.S., Elect. Eng.; Mgr., Aero. Field Service Eng. Dept., Sperry Gyroscope Co., Inc.

Hoffman, Sidney Lewis, M.S.E.; Civilian Training Administrator, Air Technical Service Command, U.S. War Dept.

Hoskins, Leonard Maxwell, Sr. Draughtsman, Vickers-Armstrongs, Limited—Supermarine Works (England).

Minter, Clarke Cothran, Ph.D.; Consultant Chemist.

Nourse, Jess Hayden, Sr. Engineer, Fredric Flader, Inc.

Ray, George Dawson, S.B. in Ae.E.; Chief Air-Frame Engineer, Bell Aircraft Corp.

Ryan, John Henry, B.M.E.; Chief Test Engineer and Hydraulics Engineer, Douglas Aircraft Co., Inc.

Samolewicz, Janusz Jerzy, M.E.; Asst. Research Engineer, National Research Council (Canada).

Schatzki, Erich, D.Eng.; Development Engineer, Republic Aviation Corp.

Scott, Charles Nolan, B.S. in M.E.; Research Engineer, Consolidated Vultee Aircraft Corp.

Sherby, Sydney Samuel, M.S. in Ae.E.; Comdr.—Chief Project Engineer—Flight Test, U.S. Navy.

Sturgis, Raynor Francis, Jr., B.S. in Administrative Engineering; Head of Technical Section—Contracts Div., Kellett Aircraft Corp.

Watson, Harold Roy, B.Sc.; Vice-President, Avocraft Limited (Canada).

Wein, Karl John, B.S.; Aero. Engineer, U.S. Army Air Forces.

Wright, Harry Otis, Jr., B.C.E.; Chief Engineer, Public Airport Services, Inc.

Transferred to MEMBER Grade

Acton, Stanley Manning, B.S. in Ae.E.; Instructor—Aero. Engineering, Tri-State College.

Bernstein, Seymour F., B. of Bus. Admin.

Gerard, George, B.Ae.E.; Sr. Research Engineer, Republic Aviation Corp.

Gould, Marcel Isaac, B.S. in Ae.E.; Wing Group Leader, Engineering Design, Canadair Ltd. (Canada).

Graetzer, Gunther R., Research Associate—Aeronautics, Wayne University.

Heyduck, Lawrence Eugene, Jr., B.S. in M.E.; Stress Analyst, Consolidated Vultee Aircraft Corp.

Lamont, Neil, B.S. in Ae.E.; Major, U.S. Army Air Forces.

Lawton, John Warren, Instructor, Flight Crews and Maintenance, U.S. Navy.

Meole, Charles Nickolas, B.S.; Instructor of Aviation Engines and Aerodynamics, U.S. Army Air Forces.

Nelson, Jack W. L., President, Servair Aviation Corp.

Rice, James Shannon, B.Ae.E.; Lt. (j.g.), Asst. Officer in Charge and Engineering Officer of VRS-1, Naval Air Transport Service Detachment, U.S.N.R.

Seamans, Robert Channing, Jr., B.S.; Asst. Prof., Aeronautical Engineering Dept., Mass. Institute of Technology.

Spring, Edward Chandler, Design Layout, North American Aviation, Inc.

Vicars, Robert James, B.S. in Ae.E.; Research, Johns Hopkins University.

Warshaw, Victor, Group Leader, Edo Aircraft Corp.

Elected to Industrial Member Grade

Cribb, Thomas George, Design Standards Engineer, Canadair Ltd. (Canada).

Shaffer, William Benjamin, B.S.; Chief Engineer, Power Equipment Co.

Elected to Technical Member Grade

Ball, Kenneth Charles, Technical Asst., Vickers-Armstrongs, Ltd.—Supermarine Works (England).

Finkel, Maurice, Structural Draughtsman (Design Office), Canadair Ltd. (Canada).

Kraft, Christopher Columbus, Jr., B.S. in Ae.E.; Aero. Engineer, N.A.C.A.

Krail, Arthur William, Jr., B.A.; Group Leader, Edo Aircraft Corp.

Lederer, Richard Wilson, Layout Man in Power Plant Group, Boeing Aircraft Co.

Schirrmeister, Gustav Henry, Engineering Draftsman, Aviation Branch, U.S. Navy.

Schouw, Arthur Charles, Copartner, Flite Guide Company.

Weber, Donald Jack, B.A.; Technical Asst., Vickers-Armstrongs, Ltd.—Supermarine Works (England).

Transferred from Student to Technical Member

Au Yong, Egbert Fitzgerald, Associate in Arts, Ae.E.; Spartan Aircraft Company (School).

Benezra, Joseph Nissim, B.S.; Professional Aero. Engineer, Ames Aero. Lab., N.A.C.A.

Borsari, Palamede, M.S. in Ae.E.; Stress Analyst, Compania Aeronautica Paulista (Brazil).

Carlson, Richard Merrill, B.S. in Ae.E.; Ensign, U.S. Navy.

Chase, William Marshall, Jr., B.S. in Ae.E.; U.S.N.R.

Christensen, Albert Thomas, Ensign, U.S. Navy.

Cohen, Clarence, B.Ae.E.; Ensign, U.S.N.R.

Cohen, Kenneth Seymour, B.Ae.E.; Ensign, U.S. Navy.

Colmer, Robert Percival, Jr., B.Ae.E.; Ensign, U.S. Navy.

Curfman, Howard James, Jr., B.S. in Ae E.; Asst. Project Engineer, Langley Mem. Aero. Lab., N.A.C.A.

Fitzpatrick, John William, B.Ae.E.; Ensign, U.S. Navy.

Fraser, William Mitchell, B.S.

Gayle, Tom Montgomery, B.S. in M.E.; Ensign, U.S. Navy.

Graves, Jack Carl, B.S. in Ae.E.; U.S.N.R.

Harrison, Daniel Edward, B.Ae.E.; Seaman 2/C, U.S. Navy.

Imster, Harry Frederick, B.S.; Ensign, U.S. Navy.

Jeffs, George William, Ensign, U.S.N.R.

Kijowski, Henry, B.S.; Student Engineer, Allison Div., General Motors Corp.

Kramer, Jacob Morton, B.S.; Student, Illinois Institute of Technology.

Levine, Sydney Herbert, B.S.; Ensign, U.S. Navy.

Maslen, Stephen Harold, B.Ae.E.; Rensselaer Polytechnic Institute.

Monahan, Raymond Edward, B.Ae.E.; U.S. Army Air Forces.

Mounger, William Robert, B.S. in Ae.E.; Ensign, U.S. Navy.

Oakes, William Jacob, Jr., B.Ae.E.; Ensign, U.S. Navy.

Peterson, John William, B.S.E.; Jr. Aerodynamicist, Cornell Aeronautical Lab.

Price, Donald Harold, B.S. in Ae.E,; Engineer, Mass. Institute of Technology.

Schmid, Robert Anthony, B.S. in Ae.E.; Stress Analyst, Beech Aircraft Corp.

Sewell, Herman Earl, Jr., B.S. in Ae.E.; Engineer, Chance Vought Aircraft Div., United Aircraft Corp.

Shipley, Harold Linwood, Jr., B.Ae.E.; Lt. (j.g.), U.S.N.R.

Trick, Robert Ernst, B.Ae.E.; Ensign, U.S. Navy.

Ullrich, Raymond Calvin, Ensign, U.S. Navy.

Uretsky, Jack Leon, B.S. in Ae.E.; Ensign, U.S. Navy.

Walker, Charles Ralph, Jr., B.S. in Ae.E.; Research Lab. Analyst "B," Consolidated Vultee Aircraft Corp.

Walker, Duncan Patrick, Ensign, U.S. Navy.

Weinstein, Jack J., B.Ae.E.; Aerodynamicist, Chance Vought Aircraft Div., United Aircraft Corp.

Williams, Robert Edd, B.S. in Ae.E.; Mgr., Gasoline Bulk Plant, The Texas Company.

Wimpress, John Kenneth, B.Ae.E.; Ensign, U.S. Navy.

Winger, Donald Clarence, B.S. in Ae.E.; Lockheed Aircraft Corp.

Necrology

Conrad Herbert Biddlecombe

Conrad Herbert Biddlecombe, Director, Armament and Equipment Supply, British Air Commission, and an Associate Fellow of the Institute, died at Coronado, Calif., on March 23, of a cerebral hemorrhage.

A graduate of the Royal Naval Colleges at Osborne and Dartmouth, England, Mr. Biddlecombe served in the Royal Navy and Royal Naval Reserve from 1906 to 1915. In 1915 he transferred to the Royal Flying Corps, and from 1918 to 1919 he served in the Royal Air Force. From 1919 to 1926 he was in the British Civil Service as Technical Aide to the Controller-General of Civil Aviation at the British Air Ministry. He came to the United States in 1926, in which year he joined Colonial Air Transport Association as Operations Manager. In 1928 he surveyed and organized Air Mail Route No. 26, from Salt Lake City to Great Falls, Mont. In the same year he became Advertising and Sales Promotion Manager for Wright Aeronautical Corporation. He then became Vice-President and General Manager of American Motorless Aviation Corporation, engaging in the manufacture of gliders and the operation of a gliding school, until 1930. In that year he entered the field of aviation-insurance brokerage. He was a member of the faculty of the Guggenheim School of Aeronautics, New York University, from 1927 to 1937, and assumed his post at the British Air Commission in 1940.

Mr. Biddlecombe was the coauthor of *Transport Aviation* and had written many technical articles for magazines.

Eugene Moritz

Eugene Moritz, Technical Translator at the Institute and a Technical Member, died at the New York Hospital on March 13.

Born at Landau, Germany, on September 1, 1878, Mr. Moritz studied at the University of Munich, majoring in chemistry, and received a Ph.D. degree.

Engaged in the translation of technical engineering articles in German, French, Italian, Spanish, and Dutch, Mr. Moritz contributed translations of foreign material to both the Aeronautical Archives and the Aeronautical Engineering Review. In addition, he assisted in the work of The Paul Kollsman Library.

American Airlines had a shielding problem

"American Metal Hose" *found the answer*

THE PROBLEM:

Ever since high frequency radio had been installed in aircraft, adequate ignition shielding had been a problem—fatigue cracking of the flexible metal shielding caused by continual vibration; moisture penetration of the conduit, causing electrical leakage and resulting in ignition failure, interrupted radio communication and schedule delays.

THE SOLUTION:

The answer to these difficulties was provided by the HTCD Shielding Conduit developed by the American Metal Hose Branch of The American Brass Company. Here is a strong, tough, corrosion and vibration-resistant, moisture-proof flexible metal tubing constructed of interlocked stainless steel core, with a covering of two specially-woven layers of tinned copper wire braiding, with brass ferrules, stainless steel nuts, and, finally, a molded Neoprene jacket.

THE RESULT:

American Airlines' flight-testing of this new shielding conduit revealed electrical characteristics never before approached in practice. After 3,712 hours and 42 minutes of operation, the conduit was in such excellent condition that tests were discontinued and it was accepted as standard. In addition, detailed cost studies revealed that the new shielding conduit cost approximately *half as much* per hour of operation as that previously used—and its ultimate life is still unknown. 46347

For practical industrial applications of American Seamless Flexible Metal Tubing and Interlocked Flexible Metal Hose, illustrated above, write for Publication SS-50.

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Personnel Opportunities

This column is for the use of individual members of the Institute seeking new connections and organizations offering employment to aeronautical specialists. Any member or organization may have requirements listed without charge by writing to the Secretary of the Institute.

WANTED

Transmission Engineer—Long-established aircraft manufacturer engaged in helicopter development requires services of mechanical designer on gear transmission work. In staff specialist capacity, position offers unusual opportunities. Aircraft experience desirable but not required. Kellett Aircraft Corporation, North Wales (Philadelphia), Pa.

Assistant Professor—To teach applied mechanics, strength of materials, and fluid mechanics. A young man with M.S. degree preferred. Applicant should have special qualifications in the field of hydraulics and fluid mechanics. Opportunity to work in fluid meters research and the development of a fluid mechanics laboratory. Address inquiries to Department of Mechanics, University of Oklahoma, Norman, Okla.

Detail and Layout Engineers, Stress Analyst—For design and development of new aircraft in Engineering Division. Write to Chief Administrative Engineer, Boeing Airplane Company, Wichita, Kan., for additional information.

Aeronautical Engineers—The U.S. Naval Air Station, Quonset Point, R.I., is accepting applications of highly qualified aeronautical engineers for future positions. Salary range from $2,320 to $5,180 per annum. Applicants may obtain Civil Service Application Form 57 from local post office. Forward applications, completely filled out to the Recorder, Labor Board, U.S. Naval Air Station, Quonset Point, R.I.

Instructor in Aeronautical Engineering—To teach courses in general aeronautics and stress sections. Must have aeronautical engineering degree. Opportunity to do graduate work. Appointment for September 15, 1946. Address: Department of Aeronautical Engineering, University of Minnesota, Minneapolis, Minn.

Assistant or Associate Professor—To conduct senior and graduate courses in airplane stress and design group. Must have M.S. degree in Aeronautical Engineering and experience in industry or teaching. Appointment for September 15, 1946. Salary open. Address: Department of Aeronautical Engineering, University of Minnesota, Minneapolis, Minn.

Aerodynamicists—College graduates with sound theoretical training and at least 1 year of graduate study in compressible subsonic flow and supersonic flow to do research and test work in the Supersonic Wind Tunnel of the Ballistic Research Laboratories, Aberdeen Proving Ground, Maryland. This is by far the largest operating supersonic wind tunnel in the country. Remuneration in accordance with qualifications. Write, giving education and experience, to The Commanding General, Aberdeen Proving Ground, Maryland, Attention: Director, Ballistic Research Laboratories.

Technical Representatives—To perform industrial representation within their resident state, county, or city for manufacturers and associated concerns throughout the country. Must have permanent position with an established company and complete domestic and technical information. Address inquiries to George E. Harris Associates, Rooms 314–318, Administrative Building, Municipal Airport, Wichita, Kan., Attention: G. E. Harris.

Design Engineers, Stress Analysts, Layout and Draftsmen—Needed for development work on experimental military aircraft, as well as production engineering. Address inquiries to Curtiss-Wright Corporation, Airplane Division, Columbus 16, Ohio, Attention: R. C. Blaylock, Chief Engineer.

Research Engineer—Theoretical Aerodynamicist or Thermodynamicist with advanced degree to engage in research on certain high-speed developments. For details write Box 1-T, Richmond 2, Va.

Design Engineers; Draftsmen—Opportunities now exist for qualified design engineers and draftsmen for work on the new stratocruiser C-97 military transport and other new developments. Here is an opportunity to become associated with one of the world's leaders in aircraft design and production and to participate in the design of the aircraft of tomorrow. Write to the Engineering Department, Boeing Aircraft Company, Seattle 14, Wash.

Aerodynamicists and Thermodynamicists—Research minded and with good theoretical background, to engage in research work on high-speed and jet propulsion developments, advanced degrees preferred. Salary commensurate to qualifications. Replies will be held in strict confidence. Write, giving education and experience, to Cornell Aeronautical Laboratory, Buffalo 5, N.Y.

Aeronautical Engineering Professor to teach Airplane Design, Airplane Structure, and related subjects. Applicants required to have a degree in aeronautical engineering as well as practical experience in the field. Preference given to candidates having advanced degrees. Facilities now under construction and plans for future construction will provide ample opportunity for research, development, and consultation. Rank and salary will depend upon training and experience of applicant. In applying please give brief sketch of personal qualifications, education, and experience. Address reply to Prof. Robert M. Pinkerton, Department of Aeronautical Engineering, A. & M. College of Texas, College Station, Texas.

Aircraft Engineers—Immediate, permanent openings for aircraft engineers with 5 years' experience in aerodynamics, structural design, and C.A.A. airworthiness requirements with Southern California aircraft manufacturer. Air-mail qualifications and recent photo to P.O. Box 29, Burbank, Calif.

Radio, Electronic and Telephone Engineers, Electronic and Mechanical Draftsmen—One of the largest manufacturers of a wide variety of electronic and communications equipment in the world is fully prepared and ready with an ambitious postwar program. Write to Personnel Manager, Federal Telephone & Radio Corp., 591 Broad Street, Newark, N.J.

Aircraft Stress Engineers thoroughly familiar with the analysis of aircraft structures, aircraft controls, and all component parts for work on helicopters. Excellent opportunities for personnel interested in rotary-wing aircraft. Apply by letter, giving references, to Administrative Engineer, Kellett Aircraft Corporation, Plant #2, Lansdowne Avenue above State Road, Upper Darby, Pa.

Personnel Needed—Executive and Administrative experience in manufacture of aircraft. Positions available in several fields: Factory and Production Management, Matériel, Tooling and Engineering. McDonnell Aircraft Corporation, Ambassador Building, St. Louis 1, Mo.

Aeronautical Engineers—for immediate work, the long-established Aeronca Aircraft Corporation seeks project engineers, design engineers, weight engineers, and layout draftsmen. These positions offer unusual permanent opportunities with the pioneer light-plane company of America for qualified men. Write in complete detail to Aeronca Aircraft Corporation, Box 00, Middletown, Ohio.

Assistant Professor of Aeronautical Engineering—To teach courses in aircraft design and aircraft structures in aeronautical engineering department of large university in Southwest. Opportunities for research in structures and in newly organized Navy Ordnance program provide for full year-round employment. Applicants should submit detailed record of education and experience. Address inquiries to Box 512, Institute of the Aeronautical Sciences.

Aeronautical Engineers—To teach mathematics, primary and advanced aeronautical engineering subjects including design and stress analysis in a Midwestern university. Address inquiries to Box 511, Institute of the Aeronautical Sciences.

Project Engineer, Chief of Structures—Excellent opportunity for qualified men with a manufacturer of medium sized aircraft. Commercial experience preferred but not necessary. Address inquiries to Box 498, Institute of the Aeronautical Sciences.

Assistant or Associate Professor—Sought by Aeronautics Department of Engineering College to teach undergraduate and graduate courses in aerodynamics, aircraft structures, or aircraft propulsion. Must have good academic training and teaching experience; constructive interest in aeronautical research and development, preferably industrial or laboratory experience in this field. Starting salary range: $3,000 to $5,000, depending upon qualifications. Address inquiries to Box 490, Institute of the Aeronautical Sciences.

Instructor—In department of mechanical engineering to teach mainly aerodynamics, aeronautical design, and develop aeronautical laboratory. Advanced degree desired. Appointment April or September as Instructor or Assistant Professor, dependent on qualifications. Location Philadelphia. Address inquiries to Box 477, Institute of the Aeronautical Sciences.

Design Draftsmen—To prepare working plans and detail drawings of new or improved products, sketching from engineering notes; checking designs for engineering accuracy; supervising some Detail Draftsmen who may be assisting. At least 5 years' experience required. Salary of $50 to $70 for 40-hour week, time and one-half for any overtime. Address inquiries to Box 476, Institute of the Aeronautical Sciences.

Aeronautical Engineers—Prominent light-plane manufacturer located in New York area seeking qualified aeronautical engineers including aerodynamicists, stress analysts, loftsmen and draftsmen, particularly those experienced in molded plywood and sheet metal structures. Military and civil contracts. Address inquiries to Box 466, Institute of the Aeronautical Sciences.

Assistant Chief Aircraft Designer—Good background and experience in civil aircraft and conversant with C.A.A. requirements. Permanent position with aircraft manufacturer in Central Eastern Coast area. Reply by letter giving particulars as to experience, salary desired, and date available. Address inquiries to Box 463, Institute of the Aeronautical Sciences.

Chief Stressman with C.A.A. requirements experience, and **One or Two Assistants,** to take charge new project. Permanent position with aircraft manufacturing firm on middle eastern coast. Reply stating full particulars of past experience, salary required, and when free to take up a new position. Address inquiries to Box 462, Institute of the Aeronautical Sciences.

Layout and Detail Draftsmen, Senior and Junior—Required for progressive aircraft program with aircraft manufacturing firm on middle eastern coast. Reply stating full particulars of past experience, salary required, and when free to take up a new position. Address inquiries to Box 461, Institute of the Aeronautical Sciences.

Aircraft Design Engineers—Immediate permanent openings for design engineers with good experience in aerodynamics, structural design and C.A.A. airworthiness requirements with aircraft manufacturing firm on middle eastern coast. Reply stating full particulars of past experience, salary required, and when free to take up a new position. Address inquiries to Box 460, Institute of the Aeronautical Sciences.

Designing Draftsman—Design ignition components of electronic and electromechanical nature. Also do follow-up on experimental orders. Should be conversant with design for low-cost production. Starting salary of $70 to $85 for 40-hour week; time and one-half for any overtime. Address inquiries to Box 458, Institute of the Aeronautical Sciences.

Assistant Engineer—Design work, test work, test analysis, and creative development work in high-frequency ignition and electrical test equipment program. Must have experience in modern electronic design, test and development methods. Starting salary of $4,200 to $4,800. Address inquiries to Box 456, Institute of the Aeronautical Sciences.

Aeronautical Engineers—Immediate positions open in Washington, D.C., for aircraft engineers with practical experience in structural design and research. Salary between $3,640–$5,180 per year. In applying please give brief sketch of personal qualifications, education, and experience. Address inquiries to Box 448, Institute of the Aeronautical Sciences.

Stress Analyst—Engineer with experience in design of rotary wing aircraft rotor blades. Must have thorough knowledge of rotor blade stress and aerodynamic analysis procedure, experimental procedure for determination of static and dynamic stresses and fatigue research methods. Permanent position involving study of wood, metal, and plastic blades. Address inquiries to Box 443, Institute of the Aeronautical Sciences.

Assistant Professor of Aeronautical Engineering—Must have experience in structural analysis and design. Permanent position. Applicants should furnish details describing education, experience, and personal data. College located in Virginia. Address inquiries to Box 442, Institute of the Aeronautical Sciences.

Assistant Professor—To conduct senior and graduate courses, develop laboratory, and direct research in aircraft power plants, with emphasis on standard aircraft engines and accessories. Advanced degree preferred. Position with an established aeronautical engineering department of a large eastern university. Appointment September, 1946. Salary open. Address inquiries to Box 434, Institute of the Aeronautical Sciences.

Aircraft Layout Draftsmen—Familiar with layout and design of aircraft sheet metal structures, controls, mechanisms, power plant, electrical systems and equipment. Excellent opportunities for experienced personnel interested in helicopter design. Address inquiries to Box 414, Institute of the Aeronautical Sciences.

Assistant or Associate Professor—To conduct undergraduate and graduate work in theory, design, and research in propellers and jet and rocket propulsion systems. Applicant should have at least one graduate degree and a sound theoretic and applied background in the thermodynamics and aerodynamics of propulsion systems. Large Midwestern University. Address inquiries to Box 413, Institute of the Aeronautical Sciences.

Project Engineer—Experienced and talented design man to undertake the responsibility for a new aircraft project from inception to completion. Plant located on eastern seaboard. Salary scale above average. Write full particulars. Address inquiries to Box 370, Institute of the Aeronautical Sciences.

Works Manager—Manufacturing executive to set up and operate a production program on a new aircraft. Will direct Manufacturing, Facilities, Inspection and Procurement Departments. Salary scale above average. Located on eastern seaboard. Write full particulars. Address inquiries to Box 369, Institute of the Aeronautical Sciences.

Airplane Salesmen—Large established producer of personal aircraft seeking several qualified airplane salesmen with both flying and merchandising experience. Interview in New York. Address inquiries to Box 362, Institute of the Aeronautical Sciences.

Associate Professor of Aircraft Structures—To teach senior and graduate courses in aircraft structural theory, develop structures laboratory, and direct graduate structural research work. Practical experience necessary. Advanced degrees preferred. Permanent position. Leading State University. Location—Midwest. Address inquiries to Box 340, Institute of the Aeronautical Sciences.

Associate or Full Professor: To teach advanced courses and direct research in the Aircraft Power Plant Design field. Recent experience in turbine and jet engine design and testing necessary. Advanced degrees preferred. Permanent position, large mid-western university. Can wait six months if necessary. Address inquiries to Box 339, Institute of the Aeronautical Sciences.

Assistant or Associate Professor of Aerodynamics—Young man with Ph.D. to teach graduate courses in theoretical aerodynamics and direct theoretical and experimental research in this field. Research experience necessary. Position permanent. Mid-western State University. Address inquiries to Box 338, Institute of the Aeronautical Sciences.

Associate or Professor of Aerodynamics—To teach performance, control, stability and develop correlating flight test and flight instrumentation courses for large mid-western university. Position permanent. Practical experience necessary. Advanced degrees preferred. Address inquiries to Box 337, Institute of the Aeronautical Sciences.

Patent Engineer—Familiar with patent disclosures and procedures. Essential helicopter industry. Salary commensurate with experience and present earning capacity. Address inquiries to Box 322, Institute of the Aeronautical Sciences.

Assistant Professor—To teach Mechanics, Strength of Materials, and Physics in a small Mid-western College. Must have Master of Science Degree, preferably in Engineering or Physics. Salary dependent on qualifications and experience. Position permanent. Address inquiries to Box 291, Institute of the Aeronautical Sciences.

AVAILABLE

Engineer—B.S. in M.E., Ae.E.; desires responsible executive position, preferably with personal plane manufacturer. Has 20 years' design, production, and executive experience which merited brief biography in *Who's Who in America*. Address inquiries to P.O. Box 503, Mt. Verhon, N.Y.

Engineer—E.E.; Executive or Administrative. Thirty-one years old. Ten years' experience electronics, servos, aircraft and industrial controls, ignition, sales engineering. Qualified in automatic temperature and propeller pitch controls and automatic pilots. Previous positions: head of research lab, central office engineer, assistant chief engineer, chief engineer. Capable of directing activities and handling men. Responsible position. Available immediately. Address inquiries to Box 271, Roslyn, L.I., New York.

Mechanical Aeronautical Engineer—B.S.M.E. (Aero Option); 29 years old; 6 years' experience on propellers and propeller accessories and manufacture of precision parts. Two years as design engineer on helicopter rotors and controls. Some experience in textile machinery and power chucks. Desires responsible position as design or project engineer in Eastern area. Address inquiries to Box 510, Institute of the Aeronautical Sciences.

Design Engineer—Five years' college education and 6 years' experience in the aeronautical field. Has been with several well-known firms on both coasts. Desires a supervisory or group leader position to initiate and carry through design features. Address inquiries to Box 509, Institute of the Aeronautical Sciences.

Aeronautical Engineer—B.S. in Ae.E. Three years' experience as assistant project engineer with prominent light plane company. One year as research engineer. Experienced in structural design, static testing, aerodynamics, and flight-test work. Familiar with C.A.A. requirements. Married; 28 years old; private pilot. Address inquiries to Box 508, Institute of the Aeronautical Sciences.

German Translations—Accurate translations of German technical literature in aeronautics and related sciences. Address inquiries to Box 507, Institute of the Aeronautical Sciences.

Aeronautical Administrative Engineer—Englishman with 18 years' aeronautical experience; A.F., Royal Aeronautical Society; Mechanical Sciences Degree (B.A. Cambridge University). Spent from July, 1938, to December, 1945, on British Government service in U.S.A. At present with Aeronautical Inspection Directorate in England. Speaks some French and a little Polish. Desires position with commercial air line anywhere, but preferably in Europe. Address inquiries to Box 506, Institute of the Aeronautical Sciences.

Aeronautical Engineer—B.S. Ae.E. from Indiana Technical College. Three years' total experience in aircraft design, overhaul, and maintenance. One and one-half years' duty in connection with aircraft maintenance as a commissioned officer in the Naval Reserve. Desires position in connection with aircraft design, production, or service. Available July 1, 1946. Any location. Address inquiries to Box 505, Institute of the Aeronautical Sciences.

Aeronautical Engineer—B.S. Ae.E. from the University of Texas. Member of Tau Beta Pi and Pi Tau Sigma. Some postgraduate work. At present is Ensign (A) L, U.S.N.R., with duties as administration officer at a naval air station. Prefers work in design or aerodynamics. Will be available about June 15. Address inquiries to Box 504, Institute of the Aeronautical Sciences.

Aeronautical Engineer—B.S. in Ae.E., B.S. in E.M. Five years' experience in design, layout, and stress analysis of large and small military and commercial airplanes with major aircraft companies. Now holds Structural Engineer rating. Experience in supervision of stress analysts, liaison engineers, and salvage engineers. Well grounded in preliminary design. Desires responsible position in aircraft or other concerns utilizing light metal stressed construction in Mexico or other Latin-American country. Available immediately. Details upon request. Address inquiries to Box 503, Institute of the Aeronautical Sciences.

Aeronautical Engineer—B.S. from Rensselaer Polytechnic Institute. Age 23. Recently discharged from U.S. Navy after 3 years' active duty as aeronautical engineering specialist. Military experience includes 2 years as air group engineering officer in charge of maintenance, repair, and servicing of all models and types of naval carrier aircraft and engines, and 5 months in the assembly and repair department of a naval air station. Desires permanent position with West Coast aircraft concern. Prefers work in aerodynamics research or stress analysis. Address inquiries to Box 502, Institute of the Aeronautical Sciences.

Aeronautical Engineer—Young, Chinese; 4 years' engineering experience; excellent connections. Desires a permanent and responsible engineering, sales, or technical position with aviation company or allied industry in China or in the Far Eastern territory. Address inquiries to Box 501, Institute of the Aeronautical Sciences.

Pilot—Engineer—B.S. in Ae.E. 1943. World War II veteran. Two years in Army Air Corps on heavy and very heavy bomber-type aircraft. Holds valid commercial pilot certificate. Prefers position involving engineering and flying but will consider engineering alone. Will locate anywhere. Address inquiries to Box 500, Institute of the Aeronautical Sciences.

Aeronautical Engineer-Aerodynamicist—B.S. Ae.E. Ten months' research experience testing wings, tail surfaces, propellers in wind tunnel.

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Six months' aircraft-engine research and development. Available immediately. New York area preferred. Address inquiries to Box 499, Institute of the Aeronautical Sciences.

Assistant Sales Manager—B.S. in M.E. Age 33; married. Ten years' aeronautical experience with two large companies. Before the war was Assistant to the Sales Vice-President of aircraft accessory firm, with extensive traveling experience. Now Major in Air Corps on terminal leave. Address inquiries to Box 497, Institute of the Aeronautical Sciences.

Aeronautical Engineer—World War II veteran; B.S. in GE with AE option from Georgia Tech. Twenty-four years old; 2 years', 8 months' experience in the development of aircraft engines (conventional and jet) and propellers in the Engineering Division, Air Technical Service Command, Wright Field. Available after June 1, 1946. Will locate anywhere. No objection to traveling. Address inquiries to Box 496, Institute of the Aeronautical Sciences.

Manufacturing Executive—Twenty years' experience in engineering and production, both United States and England. Desires connection with small concern where experience and ability can prove results. East Coast preferred. Available one month's notice. Address inquiries to Box 495, Institute of the Aeronautical Sciences.

Airline Engineer—For embryo air lines in need of financial analyses and operational and management studies. Has two aeronautical engineering degrees (working for third). Six years' aeronautical experience—air line, manufacturing, teaching. Address inquiries to Box 494, Institute of the Aeronautical Sciences.

Power-Plant Designer—Age 26, Mechanical and Aeronautical degrees. Five years' experience with power-plant installation problems including cowling and cooling, duct design, and exhaust systems. Recent experience in turbojet engine installation work, including induction systems, tail pipe, and nozzle. Excellent references. Address inquiries to Box 493, Institute of the Aeronautical Sciences.

Aeronautical Engineer—Speaks and writes Spanish. Leaving July 15 on extensive tour of South American aircraft factories, airports, and flying schools. Can handle some additional sales survey or customer liaison work. Address inquiries to Box 492, Institute of the Aeronautical Sciences.

Aeronautical Engineer—(New Zealand). First Class Honors, B.Sc. Degree at London University. Three years' postgraduate work in mathematics. Eight and one-half years' experience in major English aircraft firm, including 2 years in workshops, 1 year in wind tunnel, 3 months in stress department, and the remainder on aerodynamics and project design, such as performance, general aerodynamics, wing section theory and design, and flutter and stability control (for which now responsible). Three years on flight-test work as observer, combined with above work. Desires responsible engineering position. Available immediately, subject to travel facilities from Great Britain. Address inquiries to Box 491, Institute of the Aeronautical Sciences.

Aeronautical Engineer—Age 24; married. B.S. in Aeronautical Engineering. Two and one-half years' training and experience in maintenance and repair of all Navy-type aircraft and engines. Desires connection with air line or aircraft manufacturer in an engineering capacity. Address inquiries to Box 489, Institute of the Aeronautical Sciences.

Engineer—Design or Administrative—Twenty years' practical experience in aircraft design and administration with well-established firms. Design experience includes preliminary, proposal, and manufacturing phases of both fixed and rotary wing aircraft. Desires position of responsibility in either design or administration. East Coast preferred. Address inquiries to Box 488, Institute of the Aeronautical Sciences.

Engineer—Aeronautical, Sales and Personnel—Ex A.A.F. Major, recently released by Air Technical Service Command. Age 32; married. Military experience: 3 years as Engineering Officer at one of largest bomber plants, assisting contractor in handling engineering with prime designer and A.A.F.; approximately 1 year as service liaison engineer. Civilian experience: 1 year as Director of Personnel and Labor Relations for a leading aircraft accessory manufacturer; 3 years as sales engineer, and creator and organizer of that department for same company; 3½ years' diversified experience in retail sales, aircraft and allied industry production and engineering. Desires connection wherever experience can be best utilized. Excellent references. Address inquiries to Box 487, Institute of the Aeronautical Sciences.

Aeronautical Engineer—Graduate with 12 years' practical experience in aircraft-engine design. Familiar with engineering, development and testing of superchargers. Two years' experience as Chief Engineer in plastics plant for aircraft turrets and noses. Desires engineering position preferably supervisory. New York area preferred. Address inquiries to Box 486, Institute of the Aeronautical Sciences.

Pilot—Marine Air Corps; age 24. Commercial license with single, twin, land ratings. Partial college education in business administration. Previous practical business experience; small-scale sales experience. Desires position with aviation firm or aviation products firm in sales-contact, field representative work. Future opportunity primary consideration; salary secondary. Address inquiries to Box 485, Institute of the Aeronautical Sciences.

Aeronautical Engineer — B.S. Ae. Navigation and drafting experience in U.S. Army Air Forces. Desires position as draftsman or aerodynamicist with air line or manufacturer. Location open. Address inquiries to Box 484, Institute of the Aeronautical Sciences.

Aerodynamicist — B.Aero.E. with distinction from the University of Minnesota; age 26, married. Four full years' experience with prime Navy contractor in stability and control, compressibility, wind-tunnel test, performance, and aerodynamic design of all types of aircraft. Desires position with aircraft, business, or educational organization. Opportunities to apply knowledge and to advance are of primary interest; salary secondary. Any location considered. Available immediately. Address inquiries to Box 483, Institute of the Aeronautical Sciences.

Research Professorship—or equivalent nonindustrial research connection is desired by aircraft engineering executive, who wants to change from industrial work to fundamental research in applied physics and theoretical aerodynamics. Sc.M. in Aeronautical Engineering from Massachusetts Institute of Technology. Twenty years' experience as head of aircraft engineering department. Address inquiries to Box 482, Institute of the Aeronautical Sciences.

Physiological Psychologist—Ph.D. 1939. Ten years' research experience in the field of human engineering in aviation, including vision, visibility, cockpit illumination, exterior lighting of aircraft, instrument lighting, hearing, speech intelligibility, anoxia, fatigue, drugs, selection, crash analysis, in-flight and preflight feeding, and passenger comfort. Formerly college instructor; at present, Officer-in-Charge, Navy Lighting Projects. Desires position with an air line to develop a program of "Test and Evaluation," preferably in Department of Engineering Research and Development. Will advise engineering staff on human engineering and will test and evaluate equipment, present and proposed, with respect to efficiency of pilot and crew and to passenger comfort. Address inquiries to Box 480, Institute of the Aeronautical Sciences.

Aeronautical Engineer—Former Army pilot (all types) and engineering officer. Many years' experience in design, inspection, manufacture and test. Hydraulics and supercharger specialist. Broad knowledge of aerodynamics, thermodynamics, and design practice. Excellent engineering draftsman; holder of patents; many

ideas for future development. Desires development work on engines or airplanes. Address inquiries to Box 478, Institute of the Aeronautical Sciences.

Aeronautical Engineer—B.Ae.E. degree. Civilian experience: 1 year as aerodynamicist specializing in wind tunnel. Military experience serving with Navy as aircraft engineering officer. Age 25, married. Available in July. Desires responsible position in East or Mid-West as Aerodynamicist or Flight Test Engineer. Address inquiries to Box 475, Institute of the Aeronautical Sciences.

Aeronautical Engineer—B.S.Ae.E. degree, 26 years old, World War II veteran. Six months' experience as Fuel System Design Engineer with Air Technical Service Command, U.S.-A.A.F. Over three years' experience in the U.S. Air Corps as Flight Engineer and Maintenance Chief on heavy bombardment-type aircraft. Experienced in supervising groups. Desires a permanent design or layout position with aircraft manufacturer. Any location in the United States will be considered. Address inquiries to Box 474, Institute of the Aeronautical Sciences.

Administrative Engineer—B.A.E. Seven years' experience in airplane design (preliminary and production), research, shop work, factory liaison, and salvage work. Group Leader. Airplane and helicopter experience. Available as assistant to busy executive in general management or engineering; aircraft or allied field. New York area preferred but not essential. Address inquiries to Box 473, Institute of the Aeronautical Sciences.

Aeronautical Engineer—B.S. in Ae.E., 14 years' flying and 12 years' engineering experience including design problems, development of test and control devices, performance studies and conduct of airplane, power plant and accessory flight-test projects, seeks product-improvement position requiring design aptitude and test ability. Interests not restricted to aircraft field provided employer can benefit from aviation background. Address inquiries to Box 471, Institute of the Aeronautical Sciences.

Aircraft Power Plant Engineer—B.S. in M.E.; 12 years' in aviation with leading aircraft and engine manufacturer. During recent years in charge projects, including personnel, involving installation, operation, maintenance, and overhaul of aircraft powerplant equipment. Qualified to assume complete management of such projects. Wide acquaintance with key personnel airlines, aircraft manufacturers, distributors, service bases, A.A.F., and Navy Bureau of Aeronautics. Travel or live anywhere. Address inquiries to Box 470, Institute of the Aeronautical Sciences.

Chief or Assistant Chief Engineer—M.I.T. graduate, age 36, extensive background in research and development work and air transport engineering. Ex-Lieutenant Colonel A.A.F. Formerly Chief Aeronautical Engineer of large foreign air transport division handling all phases of aircraft engineering, maintenance, flight test, etc. Production engineering experience with A.A.F. Matériel Command at Wright Field. Heavy prewar experience in aircraft-engine development and testing. Desires position with good future leading to executive status. Location open; available immediately. Address inquiries to Box 469, Institute of the Aeronautical Sciences.

Expert Mechanical Design Engineer—Fifteen years' internal combustion engine design experience, including 3 years on diesel engines, 6 years on aircraft engines, last 2 years on high-temperature rotating machinery including gas-turbine aircraft auxiliary power plant. Interested in design supervision, engineering liaison, or sales engineering. Address inquiries to Box 468, Institute of the Aeronautical Sciences.

Aeronautical Engineer—Spanish-born and educated, author of English-Spanish aviation dictionary. Will undertake technical translations into European or Latin-American Spanish; books, brochures, advertising copy. Address inquiries to Box 467, Institute of the Aeronautical Sciences.

Aeronautical Engineer—Doctor of Aeronautical Engineering desires associate or assistant professorship in aeronautical department of university. Good teaching experience in aerodynamics and aircraft structures; several years in aviation industry on airplane design. Address inquiries to Box 465, Institute of the Aeronautical Sciences.

Tool Engineer—Aircraft and machine-shop experience; desires subcontracts for tool design, processing or special machinery. Address inquiries to Box 464, Institute of the Aeronautical Sciences.

Planning and Scheduling Engineer—M.E. degree, 1940, Carnegie Institute of Technology (Aero Option). Six years of experience. One year of experience in planning and scheduling the complete airplane before design given to project. Actual job coordinated with a representative from the factory and representative from engineering production design department and himself. Three years of experience in structural design supervision. One year of experience in engineering liaison. Desires position breaking down the design, planning the component parts and scheduling, and following its progress throughout its engineering design stages. Address inquiries to Box 455, Institute of the Aeronautical Sciences.

Management Executive—Vice-president and general manager of engineering for consulting company doing war work seeks new connection. Twenty years' experience as executive in engineering, production, and general management. Specially qualified as an organizer and production consultant. Experienced major air-line executive. Address inquiries to Box 454, Institute of the Aeronautical Sciences.

Executive—Age 37, single, Protestant, English-American. Fifteen years' continuous, well-rounded aircraft experience. Has experience in ground and flight instruction; airport and seaplane base management; airplane sales (sold over 50 aircraft prewar); charter and photographic; airline; manufacturing (inspector to factory manager); C.A.A. (inspector), quality control, engineering, research, and development. Was a key man with prime contractor (airframe) during the war (now reconverting to non-aeronautical product). Has valid commercial pilot, seven ground instructor, A. & E., radio operator, and F.A.I. glider pilot certificates. Familiar with latest metal, plastic bonded wood, and composite aircraft techniques; also conventional, amphibious, and rotating wing aircraft. Desires position where knowledge, experience, initiative, and results are of prime importance. Last salary—$7,000. Address inquiries to Box 453, Institute of the Aeronautical Sciences.

Aeronautical Engineer—With own design of practical roadable airplane having basically new and desirable features seeks connection with aircraft manufacturer who has well-established manufacturing facilities but needs a product. M.I.T. Graduate with 10 years' sound aircraft engineering experience. Address inquiries to Box 447, Institute of the Aeronautical Sciences.

Aircraft Design Engineer—Has aeronautical education. Seven years' experience in many phases of aircraft design, including layout drafting, testing, and liaison on aircraft equipment installation. Desires responsible position in engineering or experimental department of small aircraft or aircraft equipment manufacturer, or air line. Willing to travel. Address inquiries to Box 445, Institute of the Aeronautical Sciences.

Aeronautical Engineer—Twenty-two years old. Will graduate March 29, 1946, from aeronautical school. Has lived in Spanish-American country for 16 years. Writes and speaks Spanish and English fluently, thoroughly acquainted with Latin customs. Desires position in which engineering training and knowledge of Spanish and English would be of value, either in the United States or Latin America. Address inquiries to Box 444, Institute of the Aeronautical Sciences.

Aeronautical Engineer—B.S. in A.E.; age 32. Experienced in layout, design, stress analysis, and supervision in plywood and all-metal aircraft and helicopters including basic design and simplification of structures. Desires position in Mid-West if possible. Present location, Detroit. Address inquiries to Box 441, Institute of the Aeronautical Sciences.

Mechanical Engineer—M.S.E.; 32 years old; with good background in mathematics, applied mechanics, vibrations. Varied experience in research, development, and testing of mechanical products. Thoroughly familiar with mechanical laboratory methods and equipment. Desires position requiring such knowledge and experience, preferably with research and development organization. Address inquiries to Box 440, Institute of the Aeronautical Sciences.

Engineer—Administrative Liaison—Aeronautical Administrative Engineer—Seven years' air-line operation maintenance experience with international air line and U.S. Naval Air Transport Service. Lieutenant Commander, Squadron and Staff Engineering Officer. B.S. in Mechanical Engineering (Aero Option), University of California. One year, Harvard Business School. Permanent position with international transportation concern desired. Available immediately. Address inquiries to Box 439, Institute of the Aeronautical Sciences.

Aeronautical Engineer—Fourteen years actively engaged in the aircraft industry, including project design, flight test, and development engineering, and as representative in procurement and field service. Thorough knowledge of maintenance and flight operation, including A. and E. licenses and 7 years' flight experience. Present affiliation with major aircraft company, entered in 1937. Desires permanent responsible position and opportunity for advancement, commensurate with ability, in development, sales, or as technical representative. Geographical location unimportant. Four years of university work and graduate of two leading schools of aeronautics. Understands Spanish and French. Excellent commercial and military references. Address inquiries to Box 436, Institute of the Aeronautical Sciences.

Aeronautical Engineer—B.Ae.E., University of Minnesota. One year detail design and minor layout drafting. Over four years' service with Air Technical Service Command, U.S.A.A.F., as engineering officer. Military experience included one year of checking contractor-submitted stress analyses and the design and supervision of installation, in aircraft, of experimental equipment; three years as resident liaison engineer for A.A.F. at large West Coast aircraft manufacturer. Served three months in England and Germany with Air Technical Intelligence Section of U.S. Strategic Air Forces as technical investigator of German aircraft development. Desires permanent position with opportunity for advancement in technical or administrative engineering or allied field. Los Angeles area preferred. Available immediately. Address inquiries to Box 435, Institute of the Aeronautical Sciences.

Engineering Draftsman—Four and one-half years' experience in aircraft work, 1 year, sheet metal layout; 6 months, tool design; 2 years, aircraft hydraulics; and 1 year, shop liaison. Three years of college. Desires position in Chicago area with organization offering future. Will consider position in other than aircraft industries, but aircraft industry preferred. Draft exempt. Excellent references available June 1. Address inquiries to Box 433, Institute of the Aeronautical Sciences.

Aeronautical Engineer—Graduate work in Ae.E. Almost 6 years' experience in flight test, stability and control, and wind-tunnel testing on multiengined landplanes and seaplanes with large company. Desires stability and control or flight-test work with West Coast air line. Address inquiries to Box 432, Institute of the Aeronautical Sciences.

Engineer—Manufacturer—Eighteen years in aircraft industry. Experienced as Chief Engineer of large aircraft company during the war. Also experienced in operation of own company manufacturing subcontract aircraft parts. Desires position with small company having proprietary articles to engineer, manufacture, and sell. Have private pilots' license and fly own light airplane. Address inquiries to Box 431, Institute of the Aeronautical Sciences.

Aeronautical Engineer—Officer R.C.A.F. Engineering education. Six years' aircraft maintenance, liaison inspection and engineering in manufacture and overhaul of military aircraft. Considerable technical administration work. Glider construction and design experience. Desires position whereby technical qualifications can be utilized and experience to a more advanced standing possible. Future opportunity is the prime requisite. Address inquiries to Box 430, Institute of the Aeronautical Sciences.

Aeronautical Engineer—Five and one-half years' experience in Airline Engineering (Operation and Maintenance) and Aircraft Manufacturing. Two degrees in Aeronautical Engineering. Part time work desired. Address inquiries to Box 429, Institute of the Aeronautical Sciences.

Engineer—World War II veteran, engineering degree. Eight years' flying experience in U.S. Navy, 4 years service engineering, 2 years test-pilot and development work. Qualified in various types service planes including single and multiengine, both land and sea. Recent experience in jet-propelled aircraft. Desires opportunity to do research and development work including flying. No objection to traveling. Excellent references. Address inquiries to Box 427, Institute of the Aeronautical Sciences.

Air Passenger Research—College graduate, experienced. Available temporary or permanent. Address inquiries to Box 426, Institute of the Aeronautical Sciences.

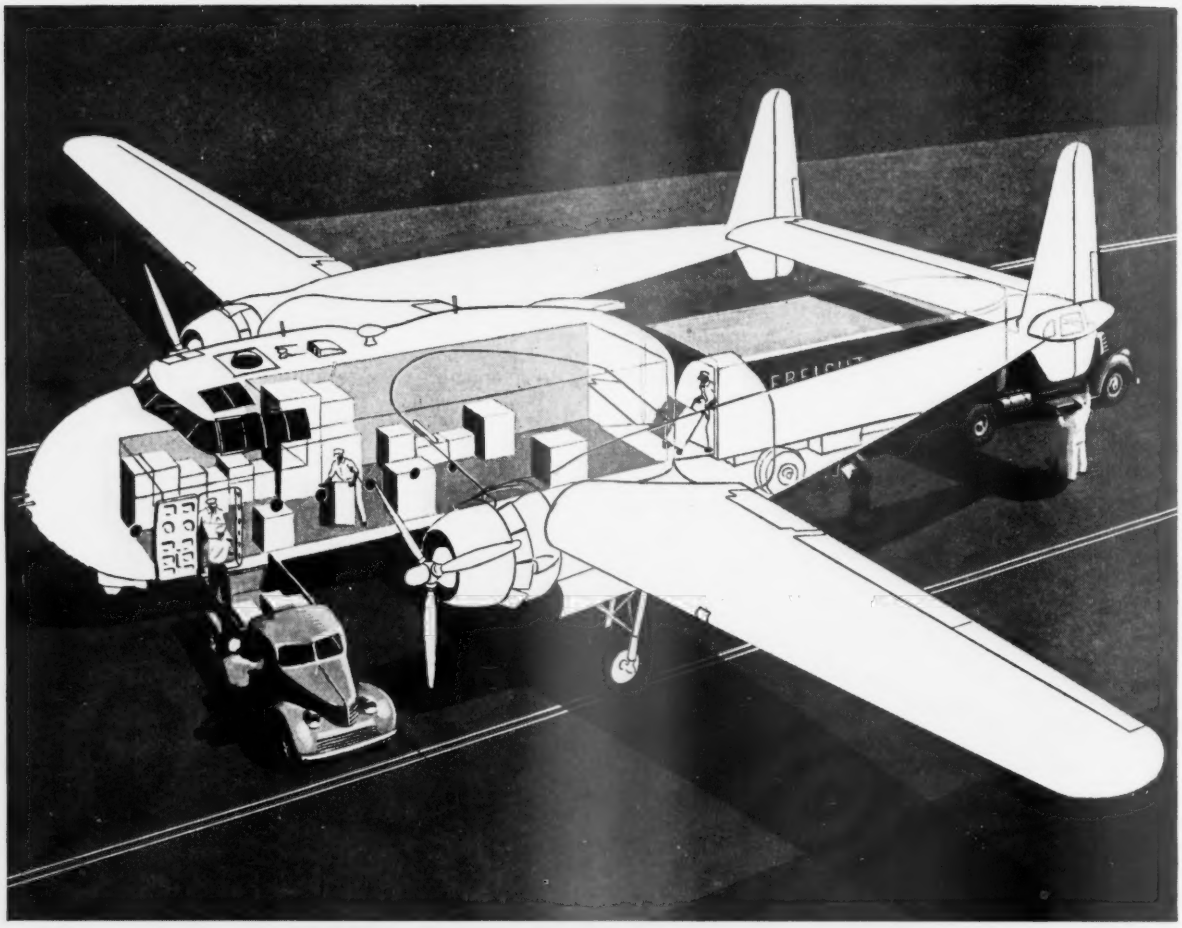
Chief Engineer, Mechanical, Development and Research—Wide experience, automotive and aeronautical, ball and roller bearings and all applications, gears, landing gear; initiated current propeller; mature judgment, capacity for detail, executive experience. Ability to analyze new design, foresee possibilities, and carry from start to production drawings. Now have paying consulting business but prefer direct responsibility. Address inquiries to Box 425, Institute of the Aeronautical Sciences.

Aeronautical Engineer—Graduate with eighteen years of practical experience in aircraft design and engineering with emphasis on aerodynamics, wind-tunnel testing, flight-testing, power plants and weights control. Desires a supervisory position in connection with aircraft design and development engineering or flight test. Address inquiries to Box 423, Institute of the Aeronautical Sciences.

Aeronautical Engineers—Recently incorporated organization of experienced engineers is interested in designing a complete airplane or any of its parts. Aerodynamic, structural, and power-plant installation problems capably executed. Complete responsibility will be assumed for obtaining C.A.A. approval. The diversified background of our engineering staff in designing for production assures a product which not only incorporates sound engineering, but also can be manufactured economically. Address inquiries to Box 422, Institute of the Aeronautical Sciences.

Aeronautical Engineer—B.Ae.E. degree. Five and one-half years' experience in stress analysis and design of large aircraft structures with a large eastern concern. Familiar with all parts of the airplane. Part time spent as group leader. Mid-West location preferred. Would like airline work. Address inquiries to Box 421, Institute of the Aeronautical Sciences.

Engineer—One and one-half years' experience as structural test engineer



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Fairchild engineers, planning the Packet to carry cargoes that no other transport can handle—made loading and stowing easy. They *squared* the fuselage. They gave it straight sides, a level floor and a horizontal ceiling. They split the fuselage tail into two doors which open the full width of the hold. They placed another door forward for access to up-front space.

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Here, then, are facilities for speed *on the ground*, vital factor in the distribution of perishables; a major element in the establishment of profitable air cargo operations.

That is the inside story of the Packet. Fairchild engineers have again achieved "the touch of tomorrow" in a plane built expressly for the dawning age of "flying freight."

Fairchild Aircraft

Division of Fairchild Engine & Airplane Corporation, Hagerstown, Maryland

and stress analyst with major aircraft company. M.E. graduate of Lowell Institute School, M.I.T. No objection to traveling. Address inquiries to Box 420, Institute of the Aeronautical Sciences.

Aeronautical Engineer—B.S. in Ae.E. with approximately 12 years' experience in military and civil airplane engineering. Complete structural responsibility on recent Navy and Army fighter airplanes with large organization. Inventive ability and productive minded. Knowledge of loads, vibrations, and flight testing. Experienced in supervising large group. Desires a permanent and responsible design or stress position in progressive organization in East or Middle West where his experience and abilities can be fully utilized. Address inquiries to Box 419, Institute of the Aeronautical Sciences.

Aeronautical Engineer, Executive—B.Ae.E., age 33, Commander U.S.N.R., available shortly. Seven years' experience in design, development, modification, overhaul and maintenance of naval aircraft, both production and experimental types. Particularly strong on structures. Administrative experience. Desires responsible position where initiative and capabilities can be employed. No objection to traveling. Willing to locate anywhere. Will consider affiliation with progressive nonaircraft organization. Address inquiries to Box 418, Institute of the Aeronautical Sciences.

Aeronautical Engineer—Bachelor's and Master's degrees in aeronautical engineering. Eight years' experience with Army, Navy, and commercial types covering all existing types of construction. Experienced in aerodynamics, structures, basic and detail design, and development and experimental work. Good knowledge of shop practices and thoroughly familiar with C.A.A. design requirements, including new CAR 03. Prefers work on small and medium-sized commercial aircraft. Any location considered. Address inquiries to Box 417, Institute of the Aeronautical Sciences.

Aeronautical Management Engineer—Registered professional aeronautical engineer with over 18 years' broad supervisory experience in aircraft engineering and production. Organization, Methods and Procedures, and Maintenance. Five years as Mechanical and Electrical Engineer. Will set up or improve organization, administrative and other control procedures, production and inspection methods and procedures, production and maintenance design; cut manufacturing, operating, and maintenance costs, initiate and maintain liaison with Government and industry for Air Line or Aircraft Manufacturer. Recently Chief, Maintenance Control and Chief, Methods and Procedures, for 2 years with U.S. Army Strategic Air Forces and Air Technical Service Command. Address inquiries to Box 416, Institute of the Aeronautical Sciences.

Executive Engineer—Graduate engineer with eight years' aircraft experience including production planning, cost estimating, master scheduling, and past five years senior design engineer. Prefers Mid-West location in aircraft or allied field. Address inquiries to Box 415, Institute of the Aeronautical Sciences.

Manufacturing Executive—Twenty years' experience, mostly aircraft, all phases manufacturing and procurement. Specialized in planning, material control, estimating, production control, procurement and production management. Available immediately. Address inquiries to Box 412, Institute of the Aeronautical Sciences.

Aeronautical Engineer—B.S Ae.E., and C.A.A. Aircraft Mechanic Certificate. Experience consists of seven months in aircraft manufacture while attending college, and two years, since graduating from college, in maintenance and design engineering on four-engined transports for commercial airline. Interested in position with another air line, manufacturer's field service technical representative, or similar work. Any location considered. Address inquiries to Box 406, Institute of the Aeronautical Sciences.

Aeronautical Engineer (native Russian)—Would like to translate Russian scientific and technical papers. Thoroughly acquainted with the field of theoretical and applied aerodynamics. Address inquiries to Box 405, Institute of the Aeronautical Sciences.

Aeronautical and Mechanical Engineer—B.S., S.M. Broad experience in theoretical and experimental stress analysis, vibration theory, and instrumentation. Project organization and customer liaison work. Long residence in the Orient. Speaks and writes Russian fluently; some French and Chinese. Interested in responsible position with consulting firm or similar organization having foreign contacts. Address inquiries to Box 404, Institute of the Aeronautical Sciences.

Development Engineer—Aeronautical engineering degree, industrial management training. Five years' experience in aircraft engine design and research aircraft production, editing. Ideal assistant for busy executive. Will conduct correspondence and technical writing, assist in project administration, planning and coordination, or handle strictly technical assignment. Address inquiries to Box 400, Institute of the Aeronautical Sciences.

Industrial Engineer—B.S.M.E. Eleven years' experience in selecting equipment and supervising installations for aircraft manufacturing processes, including experience in production of airplane motors; also 25 years' experience in the automotive engineering and production field. In a position to do consulting work as industrial engineer. Address inquiries to Box 353, Institute of the Aeronautical Sciences.

Production Executive—Mechanical engineer with 5 years' administrative experience in all phases of aircraft construction, including line assembly methods and tool and jig design, and one year as Director of Experimental. Served 10 years as Works Manager of large plant fabricating precision metal parts for automatic actuating mechanisms. Thoroughly familiar with modern precision machine-shop practice serving 8 years as Plant Manager. Manufacturing experience totals 26 years. Automotive background. Enjoys a wide acquaintance among subcontractors in central and eastern area. Will travel. Address inquiries to Box 292, Institute of the Aeronautical Sciences.

Changes of Address

To facilitate the prompt receipt of copies of the *Journal* and *Review*, members and subscribers are requested to give the Institute 30 days' notice of any change of address.

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In South America the Andes tower into the sky along nearly 5,000 miles of unbroken mountain chain. Nestled among its peaks, like the lofty homes of soaring condors, are the havens of man-made birds—the highest commercial airports on the globe.

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8,000 Feet—DC-3 Take-Off Flight Path Comparison

1. Distance required *without jet assistance* to reach a height of 50 feet, assuming one engine fails at take-off speed:

Weight	*Distance*
22,000 lbs.	5630 ft.
23,000 lbs.	6780 ft.
24,000 lbs.	(Will not leave ground)

2. Distance required, *with 1000 lbs. of jet motor thrust for 14 seconds* to reach a height of 50 feet, assuming one engine fails at take-off speed:

Weight	*Distance*
22,000 lbs.	3185 ft.
23,000 lbs.	3500 ft.
24,000 lbs.	3790 ft.
25,200 lbs.	4260 ft.

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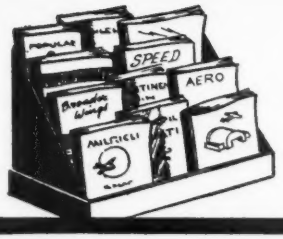

Periodicals

Accessories and Equipment

Refrigeration for Air Conditioning Pressurized Transport Aircraft. Bernard L. Messinger. Reasons are noted why refrigeration is necessary in transport aircraft. Three different methods of refrigeration are analyzed and compared. It is concluded that the air-turbine refrigeration cycle is the simplest, lightest, and most compact system for air conditioning pressurized transport airplanes. The cooling requirements of the Lockheed Constellation were used as a basis for the study. *SAE Journal*, March, 1946, pages 93–106, 119 (Transactions), 21 illus.

Expendable-Cartridge Filter. F. B. Harvuot. An outline of the functions of filters for airplane fuel systems, particularly the Bowser Expendable-Cartridge Filter for the removal of solid foreign matter and moisture from aviation gasoline. The design and operation of the filter, as well as the results derived from its use, are described. *Aero Digest*, March, 1946, page 60, 1 illus.

C-74 Cargo Loading. Hoisting facilities installed in the C-74 Globemaster for loading and unloading cargo are described. It is stated that this is the first time such equipment has been incorporated as an integral part of an aircraft. The equipment includes two traveling cranes, hoists, and a cargo elevator. The construction and use of the traveling cranes are illustrated. *Aviation Maintenance & Operations*, March, 1946, pages 46–49, 15 illus.

Aerodynamics

Aileron Reversal Speed by Influence Coefficients and Matrix Iteration. William T. Thomson. Methods most frequently used in determining the aileron reversal speed are briefly reviewed. An alternative method of determining the reversal speed, making use of influence coefficients and matrix iteration, is presented. *Journal of the Aeronautical Sciences*, April, 1946, pages 192–194, 3 illus.

Airfoil Theory for Rotary Wing Aircraft. Rufus Isaacs. In the writer's previous paper, "Airfoil Theory for Flows of Variable Velocity," there was developed an airfoil theory for a stream with a greatly varying velocity. In particular, the lift was explicitly given for the case where the velocity consisted of a sinusoidal variation superposed on a constant velocity.

The chief application of such a theory was rotary wing aircraft. In the present paper the theory, insofar as this application goes, is completed. Specifically it includes the following addenda to the paper mentioned: The angle of attack as well as the velocity is variable and the aerodynamic moment is computed in addition to the lift. The lift and moment are given specifically for the case where the angle of attack is also of the form constant plus sinusoidal variation; the frequency being the same as for the velocity variation but the amplitude and phase are arbitrary. The result is in the form of a complete Fourier series, as some applications call for a knowledge of certain higher harmonics.

To save a great deal of needless duplication the chain of ideas in the previous paper are followed closely; most of the content of this paper stresses the modifications necessary. *Journal of the Aeronautical Sciences*, April, 1946, pages 218–220.

Compressible Flows Obtainable from Two-Dimensional Flows Through the Addition of a Constant Normal Velocity. H. Poritsky. It is shown that exact solutions of the flow of compressible fluids can be obtained by starting with two-dimensional steady-state flows and superposing upon them a velocity of constant magnitude and direction at right angles to the planes of the two-dimensional flows, while at the same time, the pressure, density, and temperature of the fluid at each point are unchanged. The procedure is demonstrated by several examples, one of which is of interest in connection with the discharge of exhaust gases from a gas engine through the tail cone and tail pipe in cases where the circulation has not been completely removed from the flow. Another example is the flow around a "sweepback" or "arrow" wing. This example is illustrated for supersonic flows on plane oblique shocks and on the Meyer-Prandtl expansion around an edge. *Journal of Applied Mechanics*, March, 1946, pages A-61–A-65, 6 illus.

Airfoil Development and Structure Within the Cambered Surface. Part V. Roy A. Liming. The fifth sec-

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tion of a serial article is given to the analytic geometry involved in the determination of the axis of rotation of the retractable landing gear. The method also facilitates the solution of other problems encountered in designing that mechanism so that the main wheel can be stowed within the profile of a thin, low-drag, high-speed laminar-flow wing such as that of the Twin Mustang. After outlining the shortcomings of the graphical method of layout and the mathematical solution of the problems, the writer explains the approach to the problem by the use of analytic geometry. He proceeds first to establish, within the available wing space, an axis of rotation which meets the requirements of the two given positions, that is, the extended and the retracted positions of the wheel. The wheel is represented geometrically by a straight line corresponding to the center line of the axle. The geometric problem consists of bringing that straight line from its extended position to its retracted position within the aerodynamic profile of the wing.

The axis of rotation which will permit the achievement of that motion may be defined as a skew line in space, determined by the intersection of two planes normal to, and bisecting, the two lines determined by the two positions of two given points in the rotating system.

The analytic solution is stated to be analogous to the geometric definition of the axis and is explained in detail by means of equations, a perspective drawing of the relevant areas of the wing, and a diagram showing the rotation axis as the axis of a cone of projection. The equations are treated as a simultaneous system and then are simplified to obtain slope-intercept equations, by which the axis of rotation is defined precisely. A table based upon an actual design problem gives the seven separate steps of calculation necessary to secure the required slopes and intercepts. The mechanical routine, with the aid of a calculating machine, consumes an average of only 10 min. *Aero Digest*, March, 1946, pages 76–79, 5 illus.

Air Flow Separation at High Speed. B. V. Korvin-Kroukovsky. It is noted that the resistance coefficient of a body moving in a fluid depends on Reynolds Number R, Mach Number M, and the parameter gL/U^2, which is customarily neglected in view of small weight of the air. Here L denotes a characteristic length; U denotes the body's speed of translation. The writer points out that dimensional deduction of this parameter does not limit it to the acceleration of gravity, and that the resistance coefficient is affected by the general acceleration to which the air is subjected. Evaluation of the acceleration of the air flowing about spheres puts this parameter in the form L/R, where the characteristic length L is interpreted as the mean free molecular path.

Large and small spheres were found to have widely different values of the pressure coefficient $\Delta p/q$ for the same Reynolds Number or Mach Number. Here Δp denotes the difference in pressure between front stagnation point and the rear portion of the sphere, and q denotes the dynamic pressure. The plot of $\Delta p/q$ against the parameter L/R removes this confusion. The low values of $\Delta p/q$ are found to be associated with L/R below a certain critical value, and high values of $\Delta p/q$ with L/R above the critical value, which apparently indicates the condition under which the flow separation takes place. Attention is called to the effect of air pressure on the separation as shown by the parameter, L/R, and its possible bearing on the drag in high-altitude flying. *Journal of the Franklin Institute*, December, 1945, pages 477–485, 2 illus.

Air Cargo

What It Costs to Operate an Air Cargo Plane. John H. Frederick. A table of estimated operating expenses for a Douglas C-47 air-cargo plane is presented. The cost data are based on a 75 per cent load factor of 4,480 lbs., or 2.24 tons. These figures

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were estimated on the basis of Mentzer-Norse and Air Transport Association formulas. A brief analysis of the figures is made. *Distribution Age*, February, 1946, pages 44, 72, 1 illus.

How to Build Volume Air Freight. Richard H. Rush. The present air-freight situation is examined. It is stated that air-freight rates will have to be reduced considerably before a large volume of business can be secured. Present air express and freight rates are compared with surface-carrier rates. Means of building up air-freight business are considered and air-freight costs are analyzed. It is predicted that much of the future of air cargo will depend on the intelligence that is used in selecting shipping situations into which to fit the use of cargo planes. *Air Transport*, March, 1946, pages 26–30, 3 illus.

Air Power

Naval Air Power. Rear Adm. A. W. Radford. The Deputy Chief of Naval Operations for Air describes how naval aviation fits into the overall pattern of national defense. Seven features that he believes essential to the furtherance of peace, and the defeat of the enemy if peace is impossible, are discussed. *National Aeronautics*, March, 1946, pages 12–14, 3 illus.

Air Transport

The Future of the World Airlines: U.S.A. Lucien Zacharoff. Having considered the outlook for air lines in foreign countries in previous sections of a serial article, the writer commences a three-part study of the air transport business in the United States. Historical factors connected with the growth of America's air-transport industry are discussed. The development of air-mail and air-cargo service is traced. The effects of the last war on transport progress are described. *Air Trails*, April, 1946, pages 40–42, 115–118, 8 illus.

World Airways. Col. J. Carroll Cone. Particulars are supplied about Pan American World Airways' contributions to the national war effort. Various war activities of this air line are described and figures on the number of ocean crossings made by aircraft of this air line are given. Other data on scheduled air transport are included. *Aviation in Review*, February, 1946, pages 55–61, 1 illus.

Every Community on the Air Map. Joseph Garside. The future of charter service and feeder-line service in the United States is discussed. The form that these services will take and the requirements for dependable service are considered. *Air Transportation*, February, 1946, pages 10–12, 14, 2 illus.

Empire and Atlantic. Details of contemplated British Overseas Airways Corporation services are related. The proposals covering the coming 6 to 12 months are summarized as follows: (1) the reintroduction of a service to Australia and New Zealand by way of India, which will be operated at first four times a week to Australia and once to New Zealand, with an eventual frequency increase to seven and two, respectively; (2) a service to India by way of the Middle East, with an immediate frequency of seven a week and ultimate frequency of ten flights each way; (3) an increase in the frequency of the now weekly service to South Africa to six a week; (4) two daily transatlantic services from Heathrow —one to New York and another to Montreal, the frequency on these runs to be doubled as soon as possible —making a total of 28 flights weekly from the United Kingdom to the North American continent; (5) three flights a week, with a possible increase to four, to Accra and Lagos in West Africa, via Algiers; (6) a 9,000-mile route to Hanoi (Indo-China), Hong Kong, Shanghai, and Tokyo, by way of Vienna and the Middle East. Three new services are noted: a direct Atlantic service to New York; one to West Africa; and one to the Far East.

Included in the report are data about tentative fares and cargo rates, equipment, expected starting dates, and types of service. A table lists the services, provisional fares, inclusive time, and eventual frequencies of B.O.A.C. main lines. *Flight*, February 7, 1946, pages 143, 144; "B.O.A.C. Plans," *The Aeroplane*, February 8, 1946, pages 174–176, 2 illus.

Waging the Peace and Air Transportation. J. Parker Van Zandt. An examination of the future of international air transport, in which particular consideration is given to the way aircraft speed will reduce traveling time and to the fixing of air-transport rates. *Air Transportation*, February, 1946, pages 30–32, 34, 4 illus.

A New Plan for Business Travel. Intended particularly to increase acceptability of a company airplane to business organizations, the Faulkner Aviation Industries' system for leasing aircraft on a monthly basis is outlined. It is stated that the charges, which are based on 80 hours per month, or 1,000 hours each year, of flying, include all expenses. Specific charges and various types of airplanes available are reported. *Western Flying*, March, 1946, page 42.

Rangoon Dateline. Ralph Michaelis. A report on current air-traffic conditions around Batavia, Singapore, and Rangoon. Emphasis is placed upon the problems encountered by the Royal Air Force in trying to maintain air service in the face of certain indicated difficulties, while planning to turn the job over to commercial carriers at the earliest opportunity. *Air News*, March, 1946, pages 34–36, 5 illus.

Britain in the Air. Nigel Tangye. The current British commercial aviation situation is reviewed. Britain's achievements in commercial air transport during the war are traced with relation to the tasks ahead. *Air Transportation*, February, 1946, pages 15, 16, 18, 6 illus.

Airplane Descriptions

World's Fastest Fighter. As released by the British Ministry of Aircraft Production, further details of the Gloster Meteor IV are reported. These pertain to the aircraft's range, speeds, and climb; fuel economy; fuselage structure; wing construction; two Derwent V turbine jet power units and their mountings; armament; accessories; and undercarriage. Performance and dimension figures for the Gloster Meteor IV are listed. *Flight*, February 14, 1946, pages 157–159, 3 illus.; "More About the Meteor IV," *The Aeroplane*, February 15, 1946, pages 200–204, 7 illus.

Skyrocket Bush Plane. Descriptive details and performance data are given for the Canadian-manufactured Model 31–55A Bellanca Skyrocket. The plane is recommended by the writer particularly for "bush" operation. Specific facts and figures are summarized under the headings of dimensions; approximate weights; performance; power plant; standard instruments; and construction. *Canadian Aviation*, March, 1946, pages 35, 70, 2 illus.

New . . . On the Wing. Photographs of seven new aircraft are shown, accompanied by brief descriptions. These are the Southernaire, Convair XP-81, Miles Monitor, Douglas BT2D-1, McDonnell FD-1 Phantom, Martin Mauler, and Bristol 170. *Skyways*, April, 1946, pages 24, 25, 7 illus.

Canadian Fox Moth. A brief article supplies information about the modernization of the Canadian Fox Moth. It is noted that in basic form this aircraft is 15 years old, but that conditions for aircraft operation in "difficult" sections of the world have not altered in that time and the plane fulfills the requirements for a small, rugged, and inexpensive transport. The Fox Moth is being built at the

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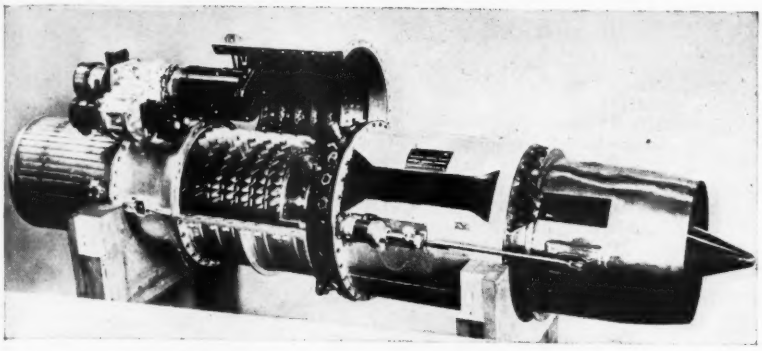

The Westinghouse 19-B axial-flow gas turbine. The engine is composed of six main sections: the oil cooler; the front bearing support casting; the compressor; the thrust bearing housing; the combustion chamber; and the turbine and tail main housing.

de Havilland Toronto factory. *Flight*, March 7, 1946, pages 241, 242, 3 illus.

Skyways Chart of Facts and Figures on the Current Crop of American Personal Planes. The following data are tabulated for each of 42 American-manufactured personal airplanes: manufacturer, seating capacity, make and horsepower of engines, price, cruising speed, range, baggage capacity, fuel capacity, type of landing gear, outstanding characteristics, and date the model is expected to be available. A series of photographs illustrating the airplanes, together with brief notes about their design, performance, and handling characteristics, supplement the table. *Skyways*, April, 1946, pages 44, 45, 28 illus.

More Variants of the Mosquito. Features of four late versions of the de Havilland D.H. 98 Mosquito are examined. The first of these planes is the Mk. 33, a Fleet Air Arm model developed from the F.B. Mk. VI, reportedly suited to fighting, bombing, torpedo-carrying, and photographic reconnaissance. The Mk. 33 has folding wings, auxiliary equipment such as pickup hook required for carrier operation, and Rolls-Royce Merlin 25 engines. Constructional changes required for these innovations are described.

The second of the Mosquito variants reviewed is the P.R. Mk. 34, an ultralong-range development of the P.R. Mk. XVI for photographic reconnaissance and fitted with Rolls-Royce Merlin 113 and 114 two-stage engines. The third is the Mk. 35, a high-altitude development of the Mosquito B. Mk. XVI, with the same engines and carrying one 4,000-lb. bomb with two 50-gal. wing tanks. A new night fighter version of the N.F. Mk. 30, but with higher-powered Merlin 113 engines, is noted in the N.F. Mk. 36. Dimensions, weights, and performance figures also are given for the four latest marks of the D.H. 98. *The Aeroplane*, March 1, 1946, pages 257–261, 9 illus.; "The Latest Mosquitoes," *Flight*, February 28, 1946, pages 205–208, 214, 11 illus.

Piper Cub Super Cruiser. C. B. F. Macauley. This description of the Cub Super Cruiser is concerned mainly with the performance and handling characteristics. The Cruiser is cited as a low-cost plane, easy to pilot, and adapted to the requirements of the private flier. *Skyways*, April, 1946, pages 18, 19, 60, 1 illus.

Four-Place Personal Design Features Novel Structural Ideas. Brief notes relative to a projected design for a four-place, low-wing personal airplane contrived to mount a ring-guarded pusher propeller aft of the tail surfaces. Features include an emergency Jato power unit; a spin-proof, two- or three-control system; retractable tricycle landing gear having a steerable nose wheel; and 8-ft. tread with knee action. The designer is also considering roadability features for this airplane, which is expected to sell for about $4,000. Top speed is estimated at 170 m.p.h., cruising speed at 150 m.p.h., and range at 600 miles. The plane will be powered by a 150–200-hp. engine turning an 84-in. diameter, four-bladed propeller. *Aviation*, March, 1946, page 50, 2 illus.

A Six-Engined Saro. Some preliminary data are given about the new six-engined Saunders-Roe flying boat project. With a gross weight exceeding 240,000 lbs. and a wing span of 220 ft., it is stated that this aircraft will attain a cruising speed of about 300 m.p.h. In general design the type will be fairly orthodox but it will be powered by gas turbines driving counterrotating propellers. The Gouge mooring system will be utilized and accommodations for passengers will vary with different versions of the model. *Flight*, February 14, 1946, page 164.

The Cessna 140. Leighton Collins. The flight characteristics of the Cessna 140 are described. Details are supplied about the arrangement and operation of the controls. The writer analyzes the performance of the plane and explains how it responds to the controls under different flight conditions. *Air Facts*, April, 1946, pages 48–60, 3 illus.

Miles Gemini. An article on the design, construction, and performance characteristics of the Miles Gemini airplane, a twin-engined type intended for personal or taxi-aircraft purposes. Powered by two Cirrus Minor II engines, it accommodates a pilot and three passengers. Structurally it is reported to be similar to the Miles Messenger, with a cruising speed of about 130 m.p.h. and a maximum speed of about 150 m.p.h. Dimensions, weights, and performances are tabulated. *Flight*, February 14, 1946, pages 162–164, 6 illus.; "The Miles M.65 Gemini," *The Aeroplane*, February 15, 1946, page 208, 6 illus.; "A Light Twin-Engined Aircraft," *Modern Transport*, February 23, 1946, page 7, 2 illus.; "The Miles 'Gemini' Aircraft," *Engineering*, February 22, 1946, pages 174, 175, 2 illus.; "The Miles M.65 Gemini," *The Aeroplane Spotter*, February 21, 1946, page 44, 4 illus.

Airports and Airfields

Are Airport Ratings Practicable? Roscoe Bancroft. The writer explains his belief that "airport rating" (by which an itinerant pilot could determine the quality of servicing, hangar, restaurant, and other facilities available at each stop) would be difficult and not always accurate. Instead, he suggests that the goal of airport improvement might be attained more effectively if the airport operators were shown specific ways in which to improve their operations.

Aircraft distributors and manufacturers, as well as oil companies, are mentioned among those who can aid the operator in offering the public more efficient and attractive service. *Airports*, March, 1946, page 31.

"Yes" Votes for That Airport. Midge Winters. A case history of a campaign that was waged in a major U.S. city to obtain an affirmative vote for a bond issue to provide adequate air terminal facilities. The city was Los Angeles; the amount of the desired bond issue $12,500,000; and the result of the advertising campaign was a 5-to-1 victory in favor of the idea.

Arguments offered by the opposition are listed and an account is given of how these objections were overcome. *Aviation*, March, 1946, pages 38–41, 4 illus.

In Case of Fire. Joe Chase. The writer offers advice regarding the fighting of fires at airports. The design and operation of the five common types of fire extinguishers are described. Types of fires are grouped into three main classes, each of which is defined. Methods used for fighting

THE HELICOPTER IS READY

Helicopters are in production! They are moving along the assembly lines at Bell Aircraft now. Naturally you want to be fully informed about this important development in aviation. Here are the facts—

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A. The first Bell helicopter to go into production is the two-place Model 47. *Nearly 500 will be completed this year.* Larger models are on the way.

Q. Who will get helicopters first?

A. Model 47 helicopters meet requirements for government agencies, disaster relief, commerce, business and industry. Organizations of this type will receive first priority.

Q. When will the first helicopters be available?

A. Deliveries will start in mid-summer and continue at a steadily increasing rate.

Soon you'll see Model 47 helicopters fulfilling the vast number of services at which they excel. For helicopters perform hundreds of practical, everyday jobs no other form of transportation can touch. They accomplish these tasks swiftly . . . flying from any point to any destination, instead of from airport to airport. For further information about Bell helicopters, write the Helicopter Division of Bell Aircraft Corporation.

The Bell Model 47B helicopter—powered by a six cylinder Franklin Aircooled engine of 175 H.P.—has a gross weight of 2100 pounds, including a useful load of 607 pounds. It utilizes a patented two-bladed rotor and gyroscopic stabilizer. The Model 47 is noted for smoothness of flight and ease of control.

BELL HELICOPTER IS FIRST IN HISTORY TO BE LICENSED FOR COMMERCIAL OPERATION

On March 8, 1946, Bell Aircraft received a CAA Airworthiness Certificate on its Model 47 helicopter, and CAA license number NC 1H, *the first helicopter "NC" license ever issued.* These certificates were issued after exhaustive flight tests in which the Model 47 met every airworthiness requirement of the CAA.

BELL OPENS SCHOOL FOR HELICOPTER PILOTS AND MECHANICS

The new helicopter school at Bell Aircraft offers six-week courses in helicopter theory and fundamentals, and in piloting and servicing to pilots and mechanics with previous aviation experience. For complete school information, write to the Helicopter Division of Bell Aircraft Corporation.

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each type are explained. *Aviation Maintenance & Operations*, March, 1946, pages 50, 88, 90, 92, 94, 96.

Aircraft Auction. Howard Earl Day. A new means of increasing airport income, promoting aircraft sales, and publicizing an airport is suggested in this account of how one airport operator held a public auction of airplanes. Problems encountered in the conduct of the transactions are noted, along with the advantages that accrued from the enterprise. *Flying*, April, 1946, pages 35–37, 10 illus.

Soil Compaction for Airports. The advantages of heavy rollers of both the "sheepsfoot" and pneumatic-tired types for compacting bases for airfields are outlined. The advantages of variable-speed and vibratory rollers also are noted. The methods and equipment used are dealt with in sections giving details and figures about the loads to be sustained and other factors. Comparisons are made of the vibration and impact methods. *Engineering News-Record*, March 21, 1946, pages 82–86, 10 illus.

Confused Cargo Facilities. John H. Frederick. Joint handling facilities are urged for air lines using the same airport. Saving of ramp space, elimination of confusion, and reduction of air-line overhead are among the advantages claimed for such consolidation. The following are noted as adaptable to combined handling: (1) moving baggage, express, and cargo to and from respective loading places on airport ramps or collection areas and the airplanes of the various air lines; (2) loading and unloading of the planes and the transfer of mail, express, and cargo between planes of the same or different air lines for forwarding; (3) operation of commissary trucks and the loading and unloading of food and containers to and from the commissary at the airport and the various planes of the air lines; (4) operation of all air-conditioning trucks and the air-conditioning of all planes no matter to which air line they may belong; (5) cleaning of the exterior and interior of the planes of any company where this is a quick job, done on the ramp, and does not involve taking planes to hangars. *Southern Flight*, March, 1946, pages 42, 43, 1 illus.

Visual Aids for "Blind" Landings. Howard M. Cone, Jr. A pilot suggests a system of lighted symbols and distinctive colors on airport runways to assure safe landings during periods of low ceiling and visibility. The system involves symbols in the form of lighted squares, triangles, crosses, circles, and bars, so placed as to indicate the position with respect to the ends of the runway, and the altitude required at the various points to maintain the proper glide path. Pertinent comments of other pilots regarding the value of the proposed system are included. *Air Transport*, March, 1946, pages 22–25, 5 illus.

The views and opinions expressed in this section are exclusively those of the writers or publications named. They are in no case to be construed as those of the Aeronautical Engineering Review or the Institute of the Aeronautical Sciences.

Building the Small Airport. Part IX. Robert C. Blatt. Airport marking is the subject of the ninth installment of an article concerning various phases of small-airport construction. It is recommended that the standard markers designed by the Civil Aeronautics Administration be installed. The writer supplies details about the installation of boundary markers, corner markers, flush boundary markers, flush circular airport ground markers, hangar markers, and highway directional markers. The effectiveness of various types of markers is shown by a diagram. Drawings of standard C.A.A. markers are included. *Aviation Maintenance & Operations*, March, 1946, pages 30–34, 96, 98, 100, 102, 15 illus.

Airport Fueling Installations. R. L. Holdridge. This investigation into the individual fueling problems connected with various types of airports advises on the best methods of fueling and the most suitable fueling equipment for each type of airport. The airports are considered in groups classified under small airfields; large Class I and small Class II airports; larger Class II fields; and largest airports. The described equipment includes only units manufactured by Erie Meter Systems. *Aero Digest*, March, 1946, pages 55, 56, 153, 4 illus.

Armament

A New Aircraft Machine Gun. Col. Rene R. Studler. The Army's new M3 0.50-cal. aircraft machine gun is described. It is explained that it provides an increase of 50 per cent in the fire power of combat aircraft, yet is practically the same size and weight as the older M2 weapon. It fires 1,200 rounds per sec., which is a 50 per cent increase over the rate of the M2. Outstanding special components of the new gun are listed. *Army Ordnance*, March-April, 1946, page 186, 1 illus.

The irregularity of receipt of publications from abroad necessitates the review of articles in issues several months late. This is done to provide readers with information regarding foreign technical progress as soon as the issues are available in the United States.

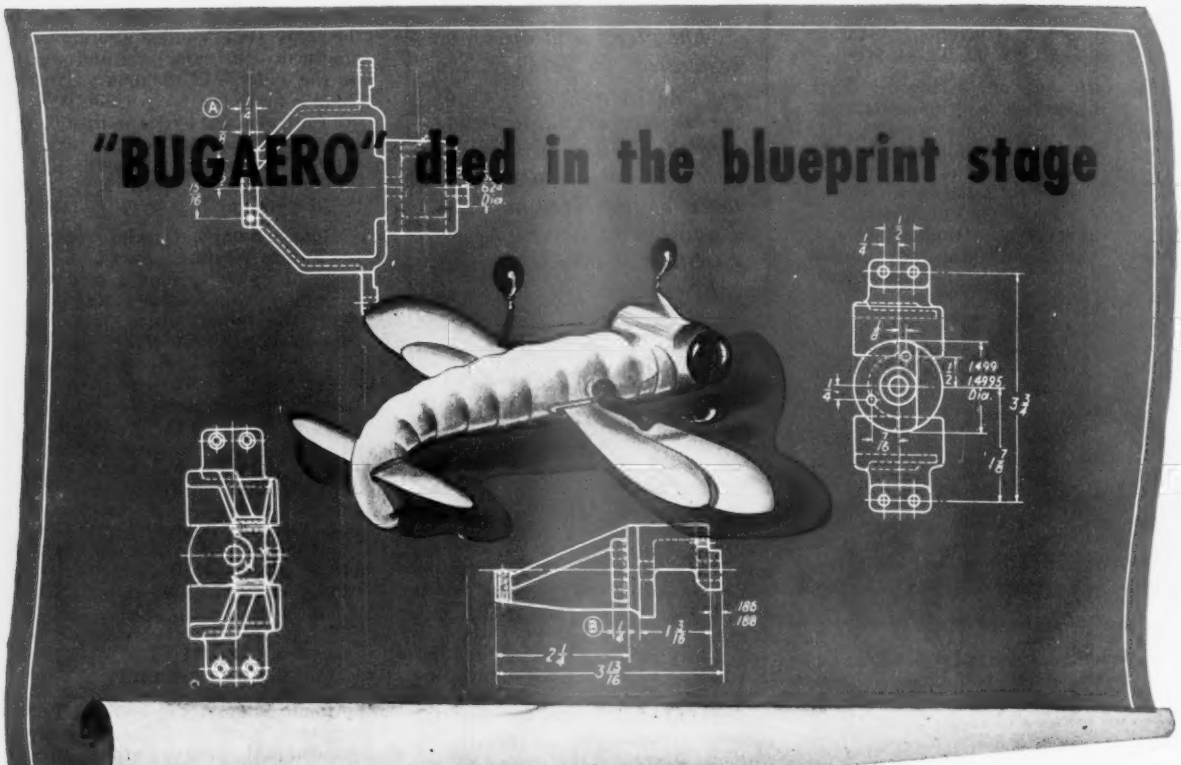
Atomic Bombs, Special Weapons, and Future Warfare. Part I. Comdr. Grayson Merrill. Part I of a series in which Commander Merrill reviews the potentialities of recently developed weapons of warfare, the part they played in the late war, and the part they are likely to play in the "next" war. Laws that seem to dictate the trend in the evolution and use of special weapons are stated, with the German V-1 bomb considered in the light of these laws. Types of special weapons are classified and their uses are described. Problems connected with the designing of special weapons are discussed. *Air Trails*, April, 1946, pages 24–26, 65, 66, 68, 70, 72, 74, 12 illus.

Atomic Energy

Atomic Energy. Hsue-Shen Tsien. A digest is given of the basic concepts involved in the study of atomic energy and its applications, with special reference to its possible use in aeronautical engineering. The writer states that its apparent principal advantage will result from the fact that atomic power plants should require a much smaller weight of fuel, and that only by the use of atomic energy will the projected supersonic flight be made economically feasible, by reducing the weight of the fuel and increasing the pay load proportionately. The release of energy through nuclear reaction is explained by an analysis of the binding energy of the atomic nuclei, using the energy generation of the stars and the atomic bomb as typical examples. Frequent comparison between molecular reaction and nuclear reaction is made as a guide to the exploration of an unfamiliar subject.

Following a brief explanation of the equivalence of mass and energy, the structure of the atom is studied. The work of various scientists in the development of nuclear reactions, which led to the discovery of a new type called the nuclear fission reaction, is reviewed. How information concerning the character of the forces between the nuclear particles was deduced is outlined by following the reasoning by which the binding force between the nuclear particles was determined, and a calculation of the nuclear binding energy is worked out. That leads to a consideration of nuclear fission and chain reaction.

The engineering approach to nuclear reaction on a practical basis is likened to the engineer's assignment, which is stated to be not so much to understand a particular phenomenon



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as to learn how to utilize it. The writer advises that a semiempirical approach would be preferable to the alternative of waiting for the development of a satisfactory fundamental theory. He believes that similar methods must be used for the development of the general utilization of atomic energy, to determine the optimum process or processes and then, finally, test the validity of the calculation by experiments. This approach would certainly eliminate, as far as humanly possible, the danger and the waste that might through improper handling be associated with the release of energy a million times as great as the conventional combustion process of molecular reaction. It is seen that the concept of nuclear-power engineering is necessarily somewhat different from its counterpart in pure science, the nuclear physics. *Journal of the Aeronautical Sciences*, April, 1946, pages 171–181, 2 illus.

Avigation

No Orchids for Mercator. "Navigus." Recapitulating the elements of map and chart design, the writer explains various methods of "flattening the globe" and the different projections by which maps are made, confining his paper to charts representing distances of many hundreds of miles, such as those used in ocean and air navigation. He outlines the necessity for constancy of scale and the greatest possible freedom from distortion, describing the orthomorphic chart particularly. This is defined as a chart in which the globe is stretched equally in all directions at any point, even though the actual amount of stretching will vary for different points. The meridians always appear as straight lines and the parallels of latitude are generally arcs of circles intersecting the meridians at right angles. Orthomorphic charts are often drawn to represent bands of latitude and are based on a "standard parallel," along which the scale is correct, although adjustments must be made in measuring distances north and south of the standard parallel. To reduce the inaccuracy by half, a chart known as the conical orthomorphic is based on the use of two standard parallels, thereby doubling the constancy of scale. That projection is known in America as Lambert's conformal projection and is favored by the writer for practical air navigation. Explanations of the use of the chart include the measurement of great-circle distances, the differences between it and the Mercator and other projections, and the extension of the principles involved to the design of position-indicating instruments. Such instruments are visualized as being used in conjunction with radio devices and made to indicate to the pilot not only the latitude and longitude, but also the number of miles or minutes required to reach the destination and the distance or time by which the airplane may be off the desired flight path. *The Aeroplane*, March 1, 1946, pages 251–254, 14 illus.

Business and Finance

Don't Get Stuck for Damages. Robert F. Carroll. To demonstrate the essentiality of airport liability insurance, a list is given of various types of damages for which owners or municipalities operating airports have been sued. Actual cases are quoted of legal suits involving the responsibility of airport operators toward nearby businesses and agricultural enterprises, personnel using the field's facilities, and the public at large. *Aviation*, March, 1946, pages 45, 146, 147.

System Saves $$$ at the Airport. Part II. Charles A. Parker. Second article in a series on the formation, systematization, and operation of an airport flying service is concerned with the organizational methods and records that lead to the monetary success of an airport operation. Examples of organizational charts are presented, and advice given on planned procedure and definite segregation of duties and responsibilities among personnel. Basic records that should be kept for a complete flying service, written agreements with customers relative to airplane hire, and the records and organizational setup required for efficient ground services are discussed. *Aviation*, March, 1946, pages 46–49, 6 illus.

W-P Is Promising Plan to Augment Export Efforts. Raymond L. Hoadley. An analysis of the Export Trade Act (Webb-Pomerene Law), with particular reference to the way in which it can be applied to aid U.S. aircraft producers and distributors to obtain foreign markets. Citing this law, which permits the formation of export trade associations as a means of enabling domestic firms to compete with the large foreign aircraft trade combinations that are being established, the writer indicates the advantages it offers to U.S. exporters. He states the functions of the export trade association as it is now conducted, reviews the background of the Export Trade Act, details some of its provisions, and describes the three general types of association agreements which have been made under the Act. *Aviation*, March, 1946, pages 99, 151–153.

Civil Aviation

Civil Aviation Licensing Changes. Proposed modifications in the licensing arrangements for British civil aviation are outlined. Four types of license are seen for powered-aircraft pilots: provisional license for student pilots under training, class "A" license for private pilots, class "B" license for commercial pilots, and class "C" license for air-line transport pilots; also, two for glider pilots; two for navigators and navigational trainees; two for flight engineers and trainees; and five for radio-telegraphy operators. Expected changes in requirements for ground staffs also are forecast. *Flight*, February 7, 1946, page 146.

Trainers in Mufti. A. H. Knouff. The usefulness of primary trainer planes, such as the Stearman, Howard, Ryan, or Fairchild, for civilian flying is questioned. The writer explains his reasons for stating that planes of this type, designed for military training work, are impractical and uneconomical for private flying and commercial operation. He recommends the purchase of smaller, lighter, more economical airplanes than the military trainers, for such purposes. *Southern Flight*, March, 1946, pages 30, 31, 3 illus.

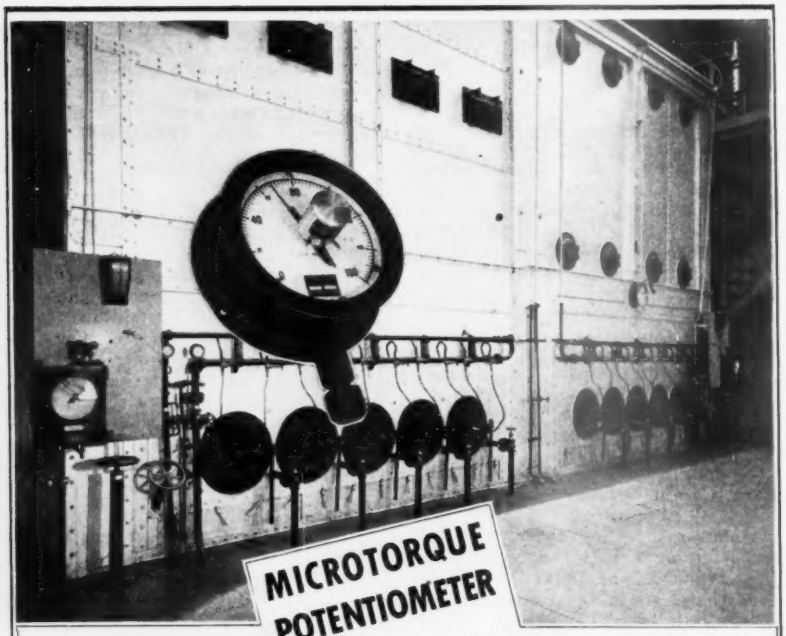
British Civil Aircraft. Important specifications of types of British civil aircraft now in use are listed in tabular form. Comments are made regarding present and future types of British civil aircraft. *Flight*, February 28, 1946, pages 210, 211.

Deicing

Propeller Icing. M. Gershzohn. Icing effects on aircraft propellers are studied. The propeller regions that normally tend to accumulate ice are indicated. The writer describes procedures that can be employed partially to deice propellers whose speed can be varied. *Journal of Aeronautical Meteorology*, October 1945, pages 13–17, 4 illus.

Design

Landing Analyses for Flying Boats and Seaplanes. Part IV. Ernest G. Stout. An additional installment supplementing a three-part article concluded in the December, 1945, issue of *Aviation* (AERONAUTICAL ENGINEERING REVIEW, February, 1946, page 52) gives information previously restricted by security regulations. The writer now is able to reveal those portions of his analysis omitted from the previous installments, following his return from a trip to Germany as a member of a Navy exploration team to study the work of German scientists in hydrodynamics. He found that the Germans had not progressed as far as the Americans in the study of hydrodynamic instability, classed as "porpoising," as applied to the alighting characteristics and water-borne performance of large flying boats. In analyzing and classifying the causes of skipping on the water surface, the action is studied by means of models operated at various speeds and different positions of the controls, to determine the proper trim at given speeds, and flight tests are made with full-scale flying boats to verify the theoretic treatment of the phenomenon. Detailed analyses are made



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of five possible variations in landing trim, illustrated by curves computed from the lift curve and the wing area of the aircraft. It is shown that skipping can be reduced or eliminated by increasing the depth of the step or supplying supplementary ventilation to the hull bottom just behind the main step. A typical example is presented of an actual case where both the step depth and the supplementary ventilation were investigated. *Aviation*, March, 1946, pages 84, 85, 148, 3 illus.

Design Analysis—Goodyear F2G. V. S. Kupelian. Numerous schematic drawings of the various components supplement this comprehensive analysis of the design and construction of the Goodyear F2G fighter airplane. Salient features examined include those relative to the propeller, power plant, lubrication system, hydraulic system, electric system, radio equipment, instrument panel, armament, wing assemblies, fuselage, and tail assemblies. Summarized, the redesign of the basic FG airplane leading to the development of the F2G is stated to encompass the following:

(1) Completely new power plant built around the Pratt & Whitney 28-cylinder R-4360 Wasp Major engine rated at 3,000 hp., including new induction, exhaust, and control systems; (2) free-blown bubble canopy for improved vision; (3) new high-altitude, deaerating automatic fuel system with two additional self-sealing fuel tanks and electrical transfer system; (4) new deaerating, automatic diverting, and regulating lubrication system of increased capacity; (5) revised and strengthened fuselage to permit installation of bubble-type canopy, additional fuselage fuel tank, and to take increased loads; (6) revised fire wall to take new oil and hydraulic tanks and the new power plant, as well as the new electrical, hydraulic, and control systems, quick disconnects, and to sustain the increased loads; (7) completely revised and rearranged cockpit, including instrumentation, controls, seat, etc.; (8) redesigned outer wing panels for increased strength and incorporation of self-sealing fuel tanks; (9) redesigned inner wing for new oil cooler installation and air ducts; (10) redesigned horizontal and vertical tail surfaces, both aerodynamically and structurally; (11) redesigned alighting and catapulting gear; (12) new and increased armor plating; (13) rearranged electronic equipment and controls; and (14) revised electrical and hydraulic systems and controls. *Air News*, March, 1946, pages 58–64, 77, 13 illus.

Designing Tomorrow's Personal Plane. Part VIII. Ralph H. Upson. The eighth section of a serial article deals with the design aspects of the passenger capacity and number of engines of an airplane for personal use. Figures are given representing the effects of variations in the number of places upon the required power,

dimensions, speed, load, and other specifications. The design factors involved in making allowance for the increased passsenger weight are investigated in connection with the form and weight of the fuselage, wing, landing gear, fuel and oil supply, drag calculations, and other considerations, leading to a study of the relative costs of building and operating the single-place type and the multiplace type. To offset the market limitations for the single-place type and provide quantity-production economies, it is suggested that interchangeability of parts or components be effected wherever possible, and other special possibilities of the single-place type are outlined. After reference to the variable-place design, providing for an extra passenger occasionally, the conclusions as to the number of places are summarized in the statement that normal range of demand might be met by (1) a one–two place with tandem seating; (2) a three–four place and a four–five place built largely to the same dimensions and with the same dies and jigs.

The consideration of the number of engines outlines the advantages and disadvantages of twin-engined and multiengined installations and their propellers, by comparison with the single-engined plant. Economic factors are held to favor the single-engined type at present, although the benefits of two or more engines may be made available through further research. *Aviation*, March, 1946, pages 76–80, 3 illus.

Beech AT-7 "Navigator." Design and engineering details of the power plant, fuselage, wing assemblies, navigation dome, cabin, movable surfaces, tail assemblies, landing gear, and oil system of the Beech AT-7 Navigator are reviewed. Photographs and sectional drawings of various components illustrate the text. Performance figures also are given. *Aero Digest*, March, 1946, pages 82–85, 153, 8 illus.

Freighter and Wayfarer. An analysis is made of the design features of the Freighter and Wayfarer versions of the Bristol Type 170 aircraft. Dimensions and performance figures for these models are listed. Illustrations show the construction of various components of these aircraft, an interior view of the Freighter's "hold," and other features. *Flight*, March 7, 1946, pages 235–240, 12 illus.

Technical Development of Fighter Aircraft. Marcus Langley and J. J. Gerritsen. The performance progress in single-seat military aircraft is studied. As a means of illustrating the advance of technical knowledge during the past 30 years, the history of fighter development is briefly reviewed. The technical qualities of typical fighters of each generation then are analyzed. *Aeronautics*, March, 1946, pages 42–47, 5 illus.

Design for Profit. Part III. H. G. Lesley. Part III of an article devoted to a study of the possibilities of redesigning transport aircraft with a view to speeding maintenance. The writer explains why he prefers hydraulic to electric controls, and circuit breakers instead of fuses. He discusses the use of rigid and flexible conduit for electric cables, and the need for better disconnect-plug design. *Air Transport*, March, 1946, pages 44, 46, 49, 5 illus.

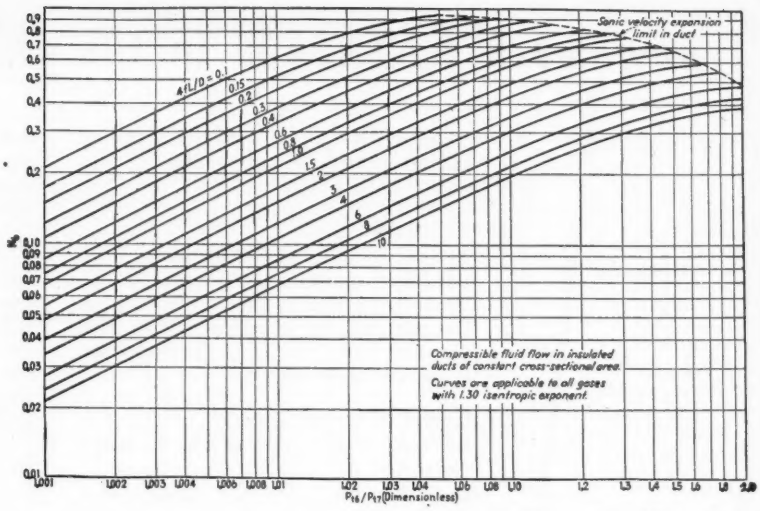

Illustration Courtesy General Electric Company

In designing ducting systems for jet propulsion power plants the above chart is useful for calculating tail-pipe pressure loss resulting from fluid friction.

Electrical Equipment

The Standard Wiring System for Aircraft. F. Emsley. Particulars are supplied about the standard wiring system that has been approved by the British Ministry of Aircraft Production for use on all new types of aircraft. The wiring system is the result of a study of previously existing systems. Research work and tests carried out in connection with the development of the standard wiring system are described. *Aircraft Engineering*, February, 1946, pages 63–67.

Engines, Gas Turbine

"River Class" Evolution. After an outline review of Rolls-Royce aircraft turbine developments, details of the Derwent V turbine-jet engine and the Trent experimental turbine-propeller unit are surveyed. In addition, a comparison is made between the features of the Derwent I and the Derwent V. Drawings, tables of data, photographs, and charts supplement the review of turbojet engine developments. *Flight*, February 7, 1946, pages 131–134, 12 illus.; "The Development of Rolls-Royce Turbo-Jets," *The Aeroplane*, February 8, 1946, pages 167–173, 11 illus.

Series II Goblin. The construction of the Goblin II turbine-jet engine is described in detail. Full performance figures, design data, and dimensions are listed. Another table indicates the construction materials used for each of the unit's important components. Noting the principal differences between the Goblin series and other turbine-jet units, as well as between the Goblin II and preceding Goblin types, the review contains particulars about this unit's direct air intake, centrifugal compressor, accessory drives, impeller, gas turbine, blades, bearings, improved combustion chambers, static structure, jet pipes, pump, fuel and oil delivery, valves, etc. Numerous sectional drawings and photographs illustrate the discussed details. *Flight*, February 21, 1946, pages 185–190, 17 illus.; "Efficiency Through Simplicity," *The Aeroplane*, February 22, 1946, pages 223–230, 16 illus.

Turbines for Aircraft. G. Geoffrey Smith. Illustrated by colored drawings, the design, construction, and operational principles of gas turbines used in aircraft are outlined. The action of a gas turbine is compared with that of a four-stroke reciprocating engine. *Flight*, February 21, 1946, pages 190a–190d, 3 illus.

The BMW 003 Jet-Propulsion Engine. Flight Officer E. A. Simonis and A. D. Moore. A design analysis of the German BMW 003 jet propulsion engine is presented. It is stated that several hundred of these engines had been built for the He 162 high-speed fighter. The engines made in the 003 series include the 003-AO, -A1, -A2, -E1, and -E2, all of which are similar and have much the same performance. A large sectional drawing of the 003-A2, the latest in the series, shows the constructional details. The engine consists of a seven-stage axial compressor, an annular combustion chamber with 16 fuel jets, a single-stage air-cooled turbine, and a variable-area exhaust jet. All auxiliaries are driven from the

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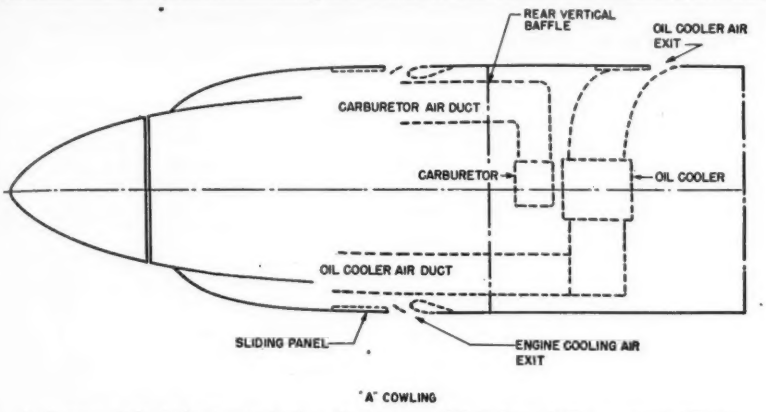


A diagram of the induction and oil cooling system of Bell Aircraft Corporation's XP-77.

front end of the compressor. Provision is made of a 125-hp. drive to a 2,200-lb. thrust rocket for increasing the rate of climb. Sections are given to descriptions of the intake, compressor, diffuser and combustion chamber, turbine, exhaust, fuel, and lubricating systems. Performance data for the engine also are supplied. *Aircraft Engineering*, February, 1946, pages 43–49, 62, 20 illus.; "Design Analysis of BMW 003 Turbojet," Major Rudolph C. Schulte, *Aviation*, March, 1946, pages 55–68, 26 illus.

Engines, General

Viewpoints: Turbines or Reciprocating Engines for Air Transport? The advantages of and objections to gas turbines and reciprocating engines for air transport service are set forth. The article is divided into two sections, one giving the points of view of proponents of the gas turbine, the other the opinions of those favoring the reciprocating engine. Factors that are considered include the relative power efficiency, fuel economy, and reliability of the two types of power plant. *Air Trails*, April, 1946, page 29.

Engines, Reciprocating

Pressure Air Cooling Technique. G. E. Lind Walker. The second and concluding part of an article in which a survey is made of present knowledge regarding "pressure air cooling" and a program for future research is outlined. Because it is not practicable to indicate the relative advantages of pressure air-cooled systems in general, owing to the complexity of various factors involved, they are indicated by numerical examples based on two hypothetic engines. The effect of increasing engine temperatures as a means of further reducing cooling drag is studied. The writer then discusses the arranging of the blower ducts to consume the boundary layer from part of the surface of the aircraft to increase aerodynamic efficiency. *Aircraft Engineering*, February, 1946, pages 38–42, 62, 8 illus.

Factors Pertaining to Installation of Inverted, In-Line Air-cooled Aircraft Engines. T. F. Hammen, Jr., and W. H. Rowley. Installation considerations singular to the inverted, in-line air-cooled engine are presented in the light of current development in that field. Much of the information is based on experience gained from wind-tunnel and flight tests with Ranger engines. Items of the installation technique are discussed in sections dealing with cooling aspects, cowling arrangements, oil cooling systems, induction systems, engine mounts, and exhaust systems. *SAE Journal*, March, 1946, pages 138–152 (Transactions), 32 illus.

Flight Technique

I'll Take Simplified Control, and ...Make Mine Conventional. Harvey Glass and R. H. Churchill. The comparative merits of simplified control versus conventional control for light planes are argued in two opposing articles. In the first, upholding simplified control, aircraft such as the Ercoupe, Skyfarer, and Ensign are cited for their safety and ease of handling. In the second, preference for the conventional stick and rudder is based upon plane control as the main factor. *Skyways*, April, 1946, pages 32, 33, 76, 78, 80, 82, 84, 86, 2 illus.

Flying the Auster J/1. Flight Lt. D. A. S. McKay. Procedures for piloting the Taylorcraft Auster J/1 are outlined. The merits and limitations of this personal aircraft are evaluated and a brief summary given of its design and performance features. In tabular form, development of the Auster is traced from Model C through J/1. *The Aeroplane*, February 22, 1946, pages 221, 222, 2 illus.

How to Fly the Fireball. T. Claude Ryan. The particular piloting techniques required for flying the Ryan Fireball are outlined by the President of Ryan Aeronautical Corporation. Certain "do's" and "don'ts" are posted, with attention called especially to the operation of the jet engines; procedures to be followed during the aircraft's climbing action; handling advantages of this airplane on a carrier and in combat; flying characteristics of the Fireball; its cockpit arrangements; and the manner in which the fuel is conveyed to either engine or to both engines. *Air News*, March, 1946, pages 37–39, 78, 5 illus.

Flight Testing

Elementary Performance Testing. T. R. Loudon. Second half of a two-part article indicating methods by which operators and pilots can carry out certain elementary tests to check the performance of their airplanes. The article is intended particularly for operators of smaller and slower types of aircraft with fixed-pitch propellers and normally aspirated engines. With the aid of charts, tables, and mathematical computations, Part II shows how to determine the best rates of climb and level speeds for a particular airplane. *Canadian Aviation*, March, 1946, pages 43, 44, 58, 5 illus.

Fuels

Aviation Fuels—What the Airlines Want and Expect. Gilbert K. Brower. Predicting that within 10 years the air lines will be using one billion gallons of fuel annually, the writer explains what the air lines would like in aviation fuels. It is stated that they are more interested in the development of economical and safe fuels of good quality than in the development of so-called "superfuels." The writer presents a résumé of the grades of fuel that he expects will be required in the future and expresses the thought that, to obtain these results, the cooperation that has developed between the fuel refiner, the engine and air-frame manufacturers, and the air-transport operators must be maintained. *SAE Journal*, March, 1946, pages 125–132, 152 (Transactions), 4 illus.

Gliding and Soaring

Schweizer's New Two-Place Utility. Franklin E. Hurtt. Features of the Schweizer SGU-2-22 two-place glider, developed especially for training purposes, are described. The desirable qualities for a training glider, all of which are said to be incorporated in the new product, are enumerated. It is stated that freedom from undesirable flight characteristics is its most outstanding feature. The general construction of the glider is explained. The fuselage is made of welded chrome-molybdenum tubing and the fairing is of steel and aluminum tubing. The whole structure is

fabric covered. Aluminum alloy is used for the rudder and fin, and the elevator and stabilizer are made from steel tubing. The general specifications are listed. *Soaring*, March-April, 1946, pages 12–14, 4 illus.

Glider Pilotage. T. A. Brown. Two main considerations in the study of glider performance—the best gliding angle and minimum sinking speed—are investigated. It is stated that most inexperienced pilots have difficulty in visualizing that the best gliding angle and the minimum sinking speed can occur as they do, nearly always, at different forward speeds. The writer then presents a simplified explanation of why this is the case. *Air Training Corps Gazette*, March, 1946, pages 9, 10.

The Evolution of the Sailplane. J. A. Simpson. Progress in sailplane developments and performance is reviewed. Present design standards are evaluated and probable future trends are estimated. Past achievements in glider performance are revealed by three graphs, showing distance, altitude, and duration record flights. Record-breaking sailplanes are described and illustrated. *Soaring*, March-April, 1946, pages 6–11, 32 illus.

Cargo Glider versus Cargo Plane and Helicopter. Richard H. Rush. An examination into the value of the commercial cargo glider—whether it is justified on business principles, and if so, where it can be profitably operated. Inherent characteristics of the cargo glider which make it commercially acceptable are analyzed. *Soaring*, March–April, 1946, pages 2–5, 2 illus.

History

The Eightieth Anniversary of the Society. A large part of the February issue of *The Journal of The Royal Aeronautical Society* is given to a report of the dinner held in celebration of the 80th anniversary of the Society, in the Guildhall of the City of London on January 11. Following the text of congratulatory messages from His Majesty King George VI, Patron of the Society, the Prime Minister, and other prominent British and American officials and civilians, the proceedings are reported in sequence. The toasts and responses are paraphrased but retain substantially the same words used by the speakers. A list of the members and guests present at the dinner concludes the account of the meeting and photographs of the assemblage are reproduced.

An account is given also of the reception and exhibition held at the headquarters of the Society on January 12, with a list of the exhibitors. The names of members of the Society who received New Year Honors are published. *The Journal of The Royal Aeronautical Society*, February, 1946, pages 76–97, 5 illus.

Instruments

Ball Integrator Averages Sextant Readings. R. F. Deimel and William A. Black. The design and operation of a ball integrator that averages sextant readings are described. The advantages of this "averager" over other types used in connection with sextants for aircraft are enumerated. The principal parts of the instrument are shown in a schematic diagram. The adjustment of the instrument is discussed in detail. *Machine Design*, March, 1946, pages 116–120, 5 illus.

Compensating and Testing the Compass. Points on compass compensation and testing are supplied in a brief article. The writer discusses compensation for deviation after the compass is installed in the airplane. He also explains how the pilot should fill out the compensation card and describes the effects of friction on compass reading. *Aviation Service Magazine*, March, 1946, pages 16–18, 3 illus.

Lubrication

Silicones as Lubricants. T. A. Kauppi and W. W. Pedersen. The lubricating possibilities of the silicones are explored. It is stated that silicone fluids may solve lubrication problems involving heat stability, oxidation resistance, nonvolatility, and low change of viscosity with change in temperature. Some silicone fluids approach the petroleum oils in their ability to reduce wear. Silicone greases, because of their oxidation resistance and low volatility, should be applicable to ball bearings under severe conditions and to permanently lubricated ball bearings where long service life is essential. Tables give the physical properties of silicone fluids and wear-test data. *SAE Journal*, March, 1946, pages 120–124 (Transactions), 6 illus.

Maintenance

Engine Disassembly Is More Than Tearing Down. E. F. Lindsley. With recommended "do's" and "dont's," proper procedures for disassembling an aircraft engine are detailed. The reader receives instructive advice with regard to the mechanical techniques of engine disassembly, disassembly sequences, and tools to be used for disassembly purposes. Suggestions are included pertinent to removal of the engine from the airplane; storage of the engine until repair is begun; unpacking engines as they come in for overhaul; incoming inspection; washing the engines before disassembly; layout of the tear-down area of the engine maintenance shop; station-to-station procedures; means of identifying parts for reassembly; disassembly inspection; protection of engine parts during tear-down; and precautions against the accumulation of debris from the disassembly procedures. *Aviation*, March, 1946, pages 89–91, 154, 156, 3 illus.

Connie Brings New Line Maintenance Procedures. George Herrick. Procedures developed by T.W.A. for the maintenance of the Constellation are described. It is noted that T.W.A. has instituted an intensive

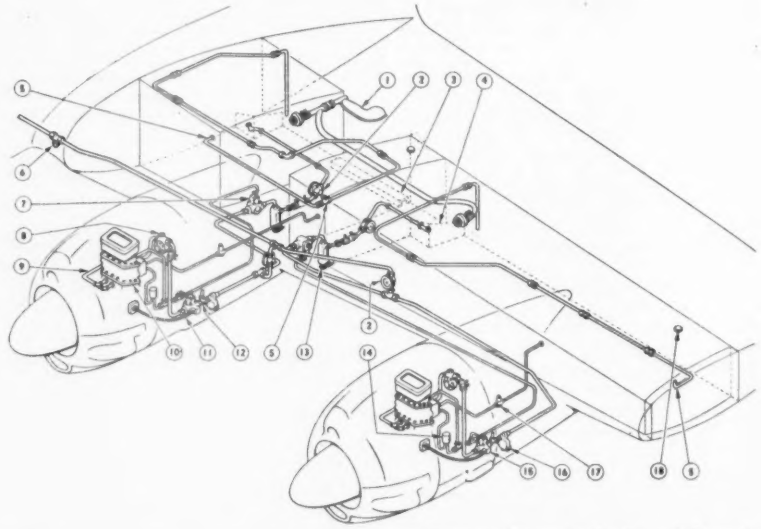


Illustration Courtesy Lockheed Aircraft Corporation

Fuel for the Lockheed Constellation is contained in two inboard and two outboard integral fuel tanks with a total capacity of 4,690 gal. The drawing shows the following: (1) fuel dump chute; (2) shutoff valve; (3) connecting tunnel; (4) surge box; (5) fuel-tank vent; (6) drain tee; (7) auxiliary fuel pump; (8) fuel flowmeter; (9) primer line; (10) carburetor; (11) flexible drive shaft; (12) oil-dilution connection; (13) fuel strainer; (14) autosyn transmitter; (15) engine-driven fuel pump; (16) solenoid shutoff valve (vapor return); (17) filler cap; (18) filler cap; (19) primer valve (solenoid operated); (20) fuel-pump case drain.

training course to familiarize maintenance personnel with the problems connected with the upkeep of this aircraft. The construction of the Constellation is analyzed from the angle of maintenance. Sections describe the hydraulic system, cabin-pressurizing equipment, oxygen system, water and fuel installations, the engines, and other features. *Air Transport*, March, 1946, pages 31–38, 9 illus.

Serviceing Advantages of the Jet-Propulsion Engine. Flight Lt. S. Cooper. The effect of present turbine engines on the maintenance periods of airplanes is discussed. Service advantages offered by the gas-turbine power unit and steps in the normal periodic inspection of a jet unit are outlined. A table provides a comparison of the inspection operations necessary in a radial engine and a jet engine. *Aircraft Engineering*, February, 1946, pages 69, 70, 1 illus.

High Spots of Pratt and Whitney Type S-1C3G Overhaul at Miami Shops of Pan American World Airways. Ralph Dobbins. The article reports some of the techniques used in the maintenance shops of an air line where Pratt & Whitney engines are overhauled. Procedures followed in disassembling, cleaning, reconditioning, and assembling the engine are outlined. *Aviation Service Magazine*, March, 1946, pages 8–11, 38, 39, 13 illus.

Line Service for Light Plane Engines. Service adjustments that must be performed on the engines of civilian-owned light airplanes are reviewed for the benefit of the airport operator. The writer explains how to avoid some of the more frequent troubles that may develop in an engine. He then gives details about a complete preflight inspection and discusses the methods of diagnosing engine troubles and performing other service operations. *Aviation Maintenance & Operations*, March, 1946, pages 28, 29, 104, 106, 108–111, 4 illus.

Management

Control of Engineering Projects. Col. T. B. Holliday. A detailed account is given of the development of the organization and the system of statistical control now used by the Army Air Forces Equipment Laboratory at Wright Field. It is described how a simple visual system presents the status of all engineering projects and indicates which are having difficulties in meeting their schedule. Charts show the organization of the laboratory. Samples of control cards, progress reports, and project records are reproduced. *Product Engineering*, March, 1946, pages 177–181, 8 illus.

Accounting for Line Sales. Todd Mumma. Procedures are described and forms are illustrated for the accurate recording of the sales and profits of the flight-line sales departments of an airport. It is explained that when

these forms are used in conjunction with other related forms of the accounting system, they will aid also in determining the important costs of other departments. *Aviation Maintenance & Operations*, March, 1946, pages 43–45, 3 illus.

Marketing

Plane Marketing Pivots on Specialized Sales Training. V. C. Rasmussen. The article emphasizes the importance of a definite training program for airplane salesmen and outlines some of the fundamentals of such a program. Two preliminary steps to a new sales-training program, two types of training which may be instituted, and implements and methods to be used in the training are discussed. To indicate the dollar-and-cents value of a good sales-training program, the results are reported of a study of 614 newly appointed sales agents, conducted by the Prudential Insurance Company for the purpose of determining (1) the influence of the men's aptitude, as gaged by tests, and (2) the gains made through a comprehensive course in the principles of salesmanship. A table of essential training factors is included with the article for checking against any company's own sales-training program. *Aviation*, March, 1946, pages 44, 149, 150.

An Expanding Market in Float Sales. The revenue possibilities for aircraft dealers in the sale of airplane floats are outlined. Claiming that there is an increasing demand for floats, the article advises on how to merchandise them properly and promote their sales. It also notes the new merchandising setup whereby floats are now sold through the same distributing organizations that sell the planes, instead of being handled by the plane manufacturers more or less as extra equipment installed at the factory. *Airports*, March, 1946, pages 27, 28, 3 illus.

Selling to the Army Air Forces. Part I. N. S. Atwell. The first installment of a continued article advising manufacturers on the opportunities for and ways of obtaining Army Air Forces business is devoted to an explanation of the methods used by the Government in purchasing material and controlling its quality. The functions of various sections of the Air Technical Service Command directly or indirectly concerned with the buying of equipment are noted. This group includes the Engineering, Procurement, and Maintenance Divisions, in addition to the Aircraft, Aeronautical Equipment, and Inspection Sections. Categories of A.A.F. equipment and supplies are listed, and a table of the A.T.S.C. laboratories and their functions is included with the article. *Aero Digest*, March, 1946, pages 26, 27, 112.

Materials

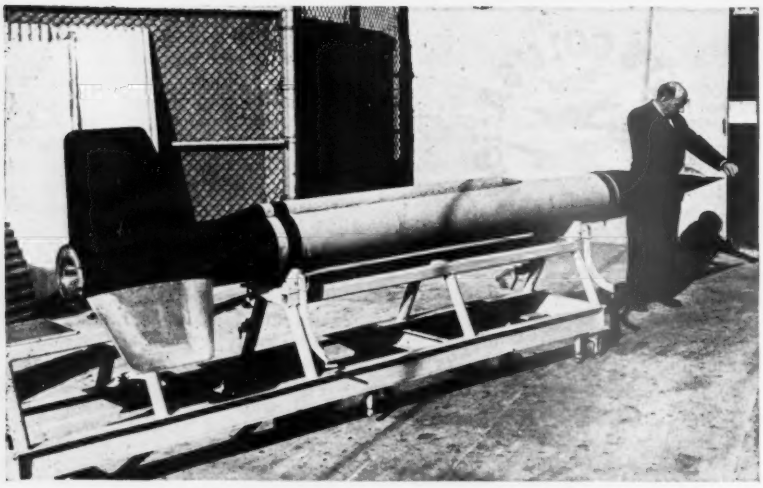
Impregnating Magnesium Castings. Samuel A. Moore. The behavior of various types of agents for the impregnation of magnesium-alloy castings is considered, with particular reference to the relationship of baking time and pressure to the efficiency of the sealing action. Data are also given about a resin-styrene compound that is nonthermoplastic and does not require an explosive chemical catalyst. *The Iron Age*, March 14, 1946, pages 76–80, 7 illus.

New Magnesium Die Casting Alloy. R. F. Hauser. The development of a new magnesium die-casting alloy for aircraft instruments which has reduced trouble from hot cracking in castings is described. The chemical composition and physical properties of the material are tabulated, and its microstructure, resistance to corrosion, and casting characteristics are outlined. Some comments are made about die-casting defects and possible means of overcoming them. It is stated that the use of the new alloy has resulted in decreased rejection rates and a consequent increase in production. *Modern Metals*, March, 1946, pages 8–10, 11 illus.

Alloys Beat the Heat. Fred P. Peters. Advances in the development of alloys suited to the ultra-high temperatures existing in turbosuperchargers, gas turbines, and jet engines are described. Reference is made to the industrial cooperation that has brought about these metallurgic achievements. Materials requirements for gas-turbine components are outlined. Details are supplied about modified stainless steels and new metals developed to meet the requirements. A diagram of the Elliott Lysholm gas-turbine cycle shows how the temperatures vary throughout the engine and indicates the metals selected for specific uses. *Scientific American*, April, 1946, pages 152–154, 4 illus.

Medicine

Physiological Problems in Aviation. A report is given in easily understood language of the physiologic mechanisms that are affected by high flying, maneuvering, and acceleration. It is explained how decreased barometric pressure influences blood oxygenation and blood movements. *Aeronautics*, March, 1946, pages 61–63, 3 illus.



A new research instrument for the Army and Navy, the rocket shown above was constructed by the Douglas Aircraft Company, Inc., for the Army Ordnance Department. In tests by the U.S. Army the new rocket ascended to 230,000 ft. or approximately 46 miles. It may be used by other Government agencies, including the U. S. Weather Bureau, to explore the atmosphere and the ionosphere. The new rocket has been under development at the California Institute of Technology.

Metallurgy

The Effect of Stabilizing and Stress Relief Heat Treatment Upon Welded 18-8 Stainless Steel. Wilson G. Hubbell. Because available information regarding the effect of stabilizing and stress relief heat-treatment on welded 18-8 stainless steel was conflicting, the investigation reported was carried out. These tests were designed to determine the particular benefits, if any, that might be imparted by these processes to 18-8 type 321 and type 347 stainless steels for use on exhaust manifolds. Benefits that would be reflected in greater serviceability of the aircraft exhaust manifolds manufactured from this steel were considered of prime importance. Details are supplied about tests that were run on columbium-stabilized and titanium-stabilized material for the purpose of determining the effect of carbide distribution on corrosion resistance. *Steel Processing*, March, 1946, pages 181–186, 6 illus.

Meteorology

Local Weather Conditions, Dayton Municipal Airport, Vandalia, Ohio. Charles K. Shafer. An analysis of weather conditions at the Dayton Municipal Airport at Vandalia, Ohio, which is based on the observations of the forecast staff during the past 2 years. The writer discusses the topography of this area and the various factors affecting weather conditions. *Journal of Aeronautical Meteorology*, October, 1945, pages 1–5, 1 illus.

Forecasting Areas of Nocturnal Thunderstorms. Paul M. Chesebrough. Types of nocturnal thunderstorms are defined. A method of forecasting the area in which such storms are most likely to occur is explained. Some examples of forecasting by this method which are included indicate that the storm area may vary widely in shape. *Journal of Aeronautical Meteorology*, October, 1945, pages 18–25, 9 illus.

Determining Indicated Altitudes from Pseudo-Adiabatic Diagram. R. A. Gage. It is observed that in forecasting bases and tops of cloud layers the pilot is interested in obtaining those values that the altimeter will show when entering and emerging from a cloud deck. That is, the indicated height of the bases and tops of the clouds is desired. The indicated height also is required in determining the freezing-level elevation for icing forecasts. Methods of determining indicated altitudes from the pseudo-adiabatic diagram are described. *Journal of Aeronautical Meteorology*, October, 1945, pages 26–28, 1 illus.

Forecasting Bay Region Stratus. G. H. Stocker. The methods of forecasting what is commonly called stratus, one of the main weather problems of the San Francisco Bay region, are reported. It is explained that this characteristic condition, which prevails during most of the season between April and October, is often a deck of stratocumulus, usually forming during the late afternoon or early evening and dissipating before noon the next day. The exact times for formation and dissipation and the heights of bases and tops vary somewhat. Because it is desirable to anticipate these factors in air-line operations, the reported investigation was made to establish forecasting procedure. *Journal of Aeronautical Meteorology*, July, 1945, pages 129–139, 13 illus.

Down Drafts Caused by Heavy Rain. C. E. Buell. In this article the effectiveness of falling rain in producing down drafts under thunderstorm conditions is considered. A relation between rate of precipitation at the ground, height of fall, and resulting down draft under rather ideal assumptions is derived and discussed with regard to aircraft operations. *Journal of Aeronautical Meteorology*, July, 1945, pages 140–143, 1 illus.

Problems of Flight Operation in the New York Area, March 17, 1942. Robert H. Ehrke. The history of a well-developed warm-front-type occlusion and its effects on weather in the Greater New York area are studied. The development was taken for examination because of its relative rarity in winter and early spring on the East Coast, and because such systems invariably present a difficult problem for the meteorologist and flight dispatcher. It is stated that this analysis of the synoptic situation of March 17, 1942, is a classic example of such a development and provides many clues as to how subsequent occluding systems in Pennsylvania and western New York might be handled in operation planning. *Journal of Aeronautical Meteorology*, July, 1945, pages 144–156, 11 illus.

An Analysis of Fog and Stratus Clouds at Amarillo, Texas. Donald M. Crowley. A report on an analysis of the formation of fog and stratus clouds at English Field, which was made for the years 1942, 1943, through June, 1944. The purpose of this investigation was (1) to determine the frequency of fog and stratus clouds; (2) to classify each case according to the single or multiple fog-producing factors causing its formation; (3) to analyze each type to determine the average meteorological elements and synoptic weather system common to it; and (4) to give examples illustrating practical methods of forecasting each type. *Journal of Aeronautical Meteorology*, July, 1945, pages 157–172, 12 illus.

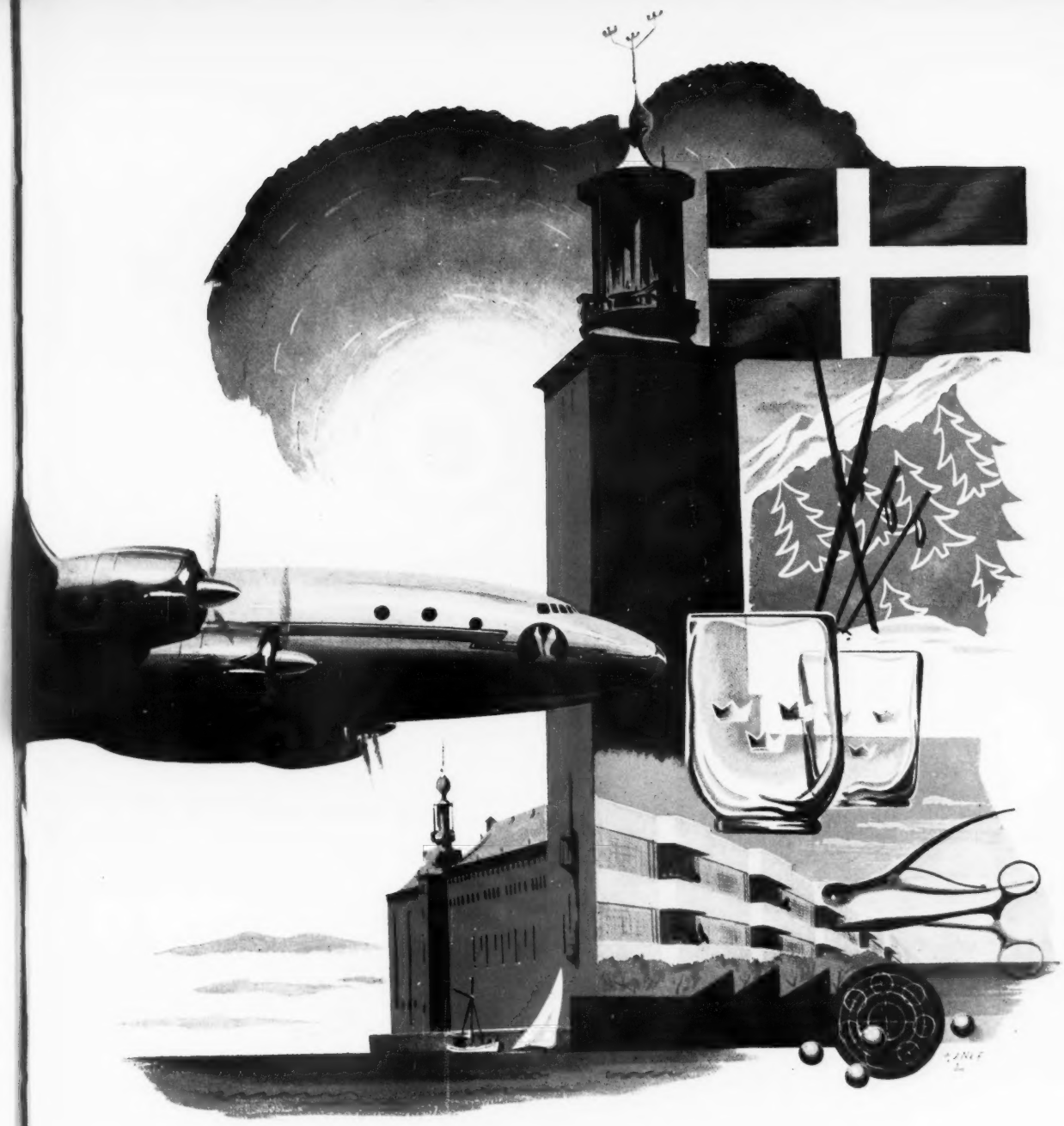
Military Aviation

Strategy of the Royal Air Force in World War II. Air Chief Marshal Sir Philip Joubert de la Ferté. Strategic operations of the Royal Air Force during the war are reviewed and analyzed. The writer discusses the bombing offensive and the lessons that can be learned from it, tactical bombing, air-sea operations, fighter defense, and air transport. *Aeronautics*, March, 1946, pages 28–31, 3 illus.

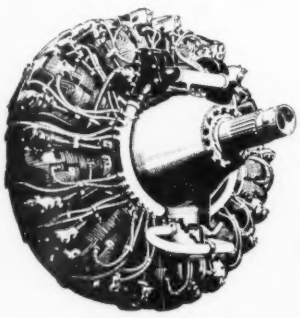
Brothers Under the Sky. Air Marshal Douglas Colyer. Commenting on the spirit of cooperation achieved between the American and British air forces, Air Marshal Colyer includes some graphic descriptions of how the Royal Air Force rescued members of the Army Air Forces downed at sea. *Aviation in Review*, February, 1946, pages 29–32.

Model Airplanes

Tiny Jet Engines Perfected for Models. Developments in miniature



FLAGSHIPS IN THE MIDNIGHT SUN



Saving nine days time, planes of American Overseas Airlines now fly from America to Sweden and lands of the midnight sun. To this northland nation . . . trade keystone of the Baltic, gateway to Finland and Russia . . . travel is now cut to a day, by the speed of Lockheed Constellations and the power of Wright Cyclones.

WRIGHT *Aircraft Engines*

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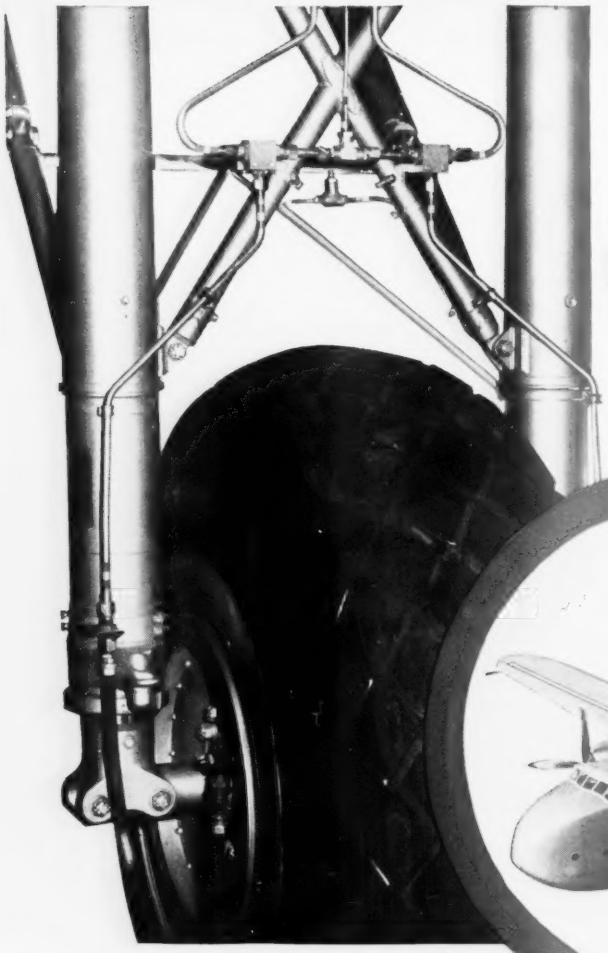


Main leg Aerol on the "Packet"

AEROLS

PROTECT THE PACKET'S PAYLOADS

Illustrated is the Fairchild "Packet", a transport plane with many innovations in design. Its spacious hold is almost as large as a railway boxcar. To promote more efficient cargo handling, the "Packet's" level floor is at truckbed height.

• When landing, this unique plane and its heavy cargo are protected by the reliable shock-absorbing action of Cleveland Pneumatic nose and main leg AEROLS . . . It is significant that not only the "Packet", but most other large transports now in service are Aerol-equipped.

AEROLS*

*PNEUMATIC-HYDRAULIC (AIR-OIL) SHOCK ABSORBING LANDING GEAR

THE CLEVELAND PNEUMATIC TOOL COMPANY
AIRCRAFT DIVISION • Cleveland 5, Ohio

jet engines for use in experimental model airplanes are described. It is stated that these jet engines develop more power for their weight than their full-sized counterparts and have been perfected for wind-tunnel model jet fighter research. Details are supplied about a unit developed by the Air Technical Service Command which weighs only 5 oz. and develops 2 lbs. of static thrust. Several makes of jet engines manufactured for use in model planes also are described. All operate on the ram jet principle. *Aviation News*, March 25, 1946, page 10, 2 illus.

Naval Aviation

The Carrier Task Force in World War II. Lt. William H. Hessler. The role of the Navy's carrier task force in various naval operations of World War II is described. It is stated that when the first strike was made against the outer screen of Japanese positions the dive bomber played the major role. In later operations against Japanese fleet elements the dive bomber and torpedo bomber shared the honors. When the scene of conflict moved westward to combat the enemy's land-based air force, the Hellcat became the primary offensive weapon. After that, the urgent mission became strategic bombing, which the Navy carried out with other carrier-based aircraft types. *United States Naval Institute Proceedings*, November, 1945, pages 1271–1281, 4 illus.

Naval Aviation Tomorrow. Vice Adm. Marc A. Mitscher. Noting aeronautical and related developments sponsored by the U.S. Navy during the war, the Commander of the 8th Fleet reports on some of the scientific and technical research that the Navy is now pursuing for further aviation progress. Attention is called to the Navy's current experimental work in electronics, new types of piloted aircraft, radio-controlled planes, jet propulsion, guided missiles, and rockets. Its efforts to improve night fighting, communications, armament, air safety, construction materials, methods of protecting fuel and oil systems, training devices, aerial photography, and aerology also are recounted. Three specific innovations in the guided-missiles field are described briefly—the "Glomb," the "Gorgon," and the "Gargoyle." *Flying*, April, 1946, pages 22, 23, 92–94, 4 illus.

Future of Naval Research. Lt. Comdr. E. S. Franklin. The part research will play in naval aviation of the future is discussed. Some aviation-research activities of the Navy are outlined. The subject is considered in sections dealing with electronics for the future, developments in aircraft armament, carriers and catapults, aircraft power plants, equipment and material, special devices, photography, and aerologic instruments and facilities. *American Helicopter*, March, 1946, pages 25, 42, 43, 45.

Paints and Coatings

A Flight Investigation of the Effects of Surface Finish on Wing Profile Drag. W. H. Day and J. M. Schwarzbach. An investigation in flight was conducted on a Curtiss P-40F airplane to determine the effect on the section profile drag of smoothing the wing surface. A total and static pressure rake, located aft of the wing trailing edge in the wake of the test section, measured the loss in momentum from which the sectional profile drag coefficient (c_{d_0}) was calculated. The airfoil section at the plane of measurement was approximately an NACA 2212.8 profile. For each surface finish condition, data were taken at values of airplane lift coefficient varying between $C_L = 0.15$ and $C_L = 0.35$. The corresponding Mach Numbers were between $M = 0.28$ and $M = 0.41$.

The surface finish smoothness has a large effect on the profile drag coefficient. At an airplane lift coefficient of $C_L = 0.16$ ($RN = 16.5 \times 10^6$, $M = 0.405$), four degrees of wing surface smoothness produced the following values of c_{d_0}:

Fresh camouflage paint (standard production type finish)	$c_{d_0} = 0.0088$
Above paint after several days of weathering	$c_{d_0} = 0.0083$
Above paint sanded and pumiced	$c_{d_0} = 0.0078$
Wing surface filled and smoothed to obtain as aerodynamically smooth a surface as possible	$c_{d_0} = 0.0064$

Calculations made on the basis of these data indicate that an appreciable improvement in performance could be obtained merely by smoothing the factory-finished wing.

Two flights, one with a thick mud layer on the wing and the other with a somewhat lighter layer, indicated the necessity of flying with clean wings. The thin layer of mud caused a drag increase above the production wing of about $\Delta c_{d_0} = 0.0035$, while the addition of the heavy mud caused the profile drag to be slightly more than double that of the factory-finished wing. These surfaces were tested to show what might be expected in actual combat service.

This investigation also indicated that calculations made with the simplified Silverstein-Katzoff integrating equation, corrected for compressibility, yielded values of profile drag coefficient substantially equal to those calculated by use of a more exact equation that required lengthy point-by-point integrations across the wake to determine c_{d_0}. *Journal of the Aeronautical Sciences*, April, 1946, pages 209–213, 217, 5 illus.

A Protective Finish for Magnesium Alloys. R. B. Mason. A method of producing a relatively heavy protective coating on magnesium alloys is described. The finish, which has high abrasion and corrosion resistance, is produced by anodic oxidation of the magnesium alloy in a sodium hydroxide electrolyte followed by sealing in a chromate solution. Curves show the effect of time on the thickness of the oxide coating, and the effect of time and current density on the abrasion resistance of the coatings formed on magnesium-alloy sheet. A table contains data on exposure tests of coatings used as paint bases on magnesium alloys. *The Iron Age*, March 21, 1946, pages 48–52, 7 illus.

Parachutes

The Versatile Chute. Frank Ross, Jr. The writer outlines some emergency uses, other than lifesaving, to which the parachute can be put. The uses of the nylon parachute as a tent or lean-to type shelter, as an emergency means of making wearing apparel, and as a seine for procuring fish are noted. It is explained that the nylon canopy, the shroud lines, metal attachments, the rubber seat, and the harness lend themselves to many uses by airmen stranded in the Arctic, tropics, or desert. *Air World*, May, 1946, pages 37, 54, 3 illus.

Personalities

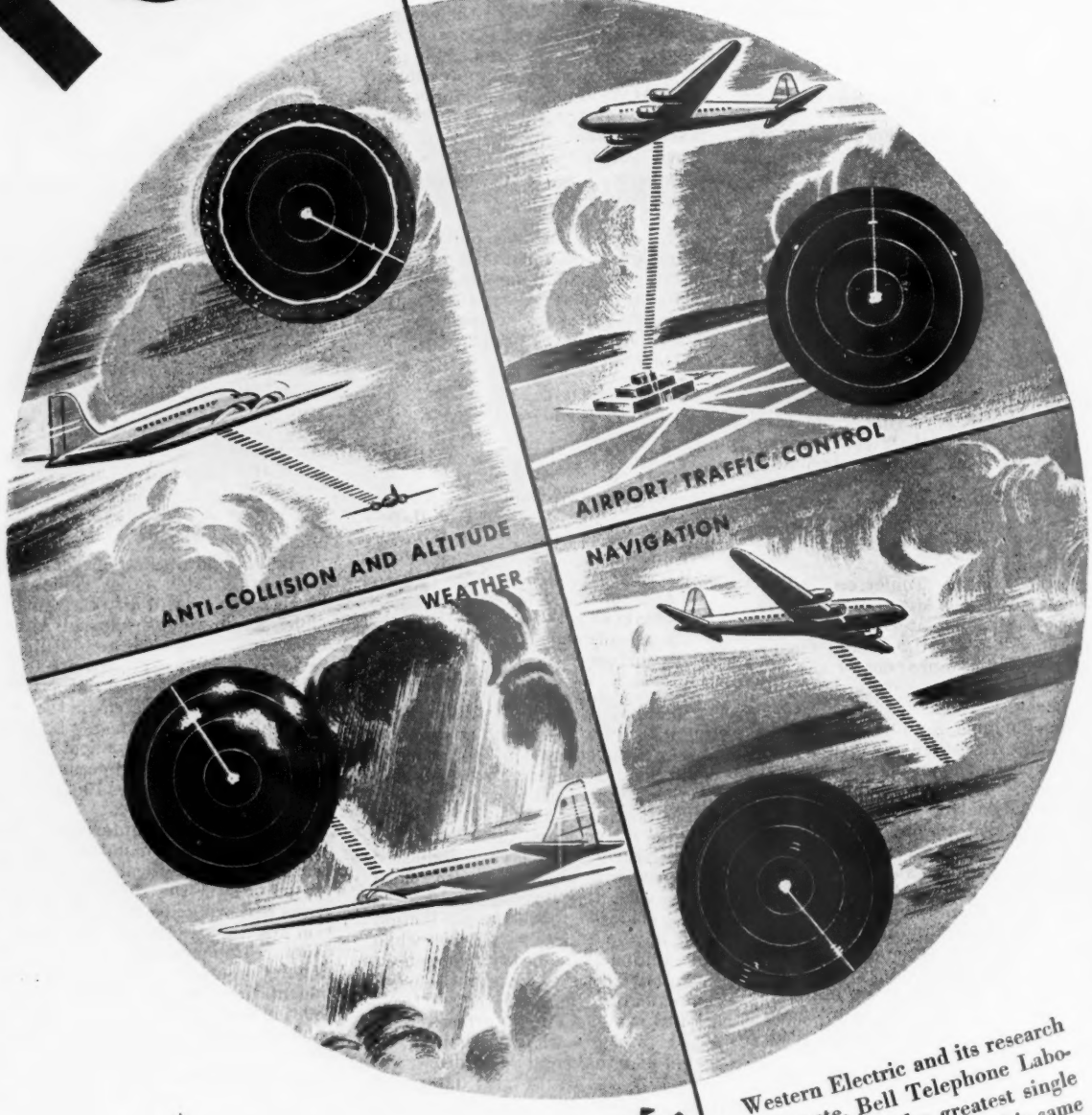
Hall Hibbard, Prophet of Speed. Norman Carlisle. A biographic sketch of Hall Hibbard, Vice-President and Chief Engineer of Lockheed Aircraft Corporation, traces his early life and reviews his many activities and achievements in the field of aviation. The part he has played in the creation of the Lightning, Lodestar, Hudson, Constellation, Shooting Star, and other aircraft is described. *Air World*, May, 1946, pages 19–21, 64–66, 4 illus.

Chanute Calls a Conference. John Hettich. Octave Chanute's contributions to aeronautical progress are the subject of the third sketch in a series reviewing the pioneers of aviation and their exploits. The story of Chanute's sponsorship of an International Conference on Aerial Navigation at the Chicago World's Fair of 1893 is related, and note made of papers presented at the Conference which contributed to the era's knowledge of aerodynamics. Attention is called also to a series of experimental aircraft sponsored by Chanute, including a practical biplane design. *Aero Digest*, March, 1946, pages 28, 154, 156, 1 illus.

Sikorsky, Rotary-Wing Genius. In a review of the life of Igor Sikorsky, particular emphasis is placed on his activities in the development of the helicopter. The different types of helicopter he has designed are described and illustrated. *American Helicopter*, March, 1946, pages 34–38, 9 illus.

radar

FOR SAFER, FASTER, MORE DEPENDABLE OPERATION



Western Electric and its research teammate, Bell Telephone Laboratories, were the greatest single source of radar in war. This same team will be in the forefront of development and production of airborne radar in peace.

Western Electric

Plants

Operating and Maintenance Charges for Air Conditioning Machine Shops. H. B. Lammers. The article contains information about the cost of operating and maintaining the heating, ventilating, and air-conditioning equipment of the Lockland, Ohio, plant of the Wright Aeronautical Corporation. The writer explains why air conditioning of the plant is necessary and briefly describes the equipment. Tables of air-conditioning design and cost data are included. *Heating, Piping & Air Conditioning*, February, 1946, pages 93–96, 4 illus.

Plastics and Plywood

Manufacture of Compreg in Germany. R. Richardson and G. M. Kline. Information is summarized from reports of various technical committees that have been investigating German industrial processes. The current article refers to the manufacture of compressed wood materials. It describes a wide variety of manufacturing techniques, including those used in the production of materials for propellers, aircraft dies, and gear stock. *Modern Plastics*, March, 1946, pages 155–159, 11 illus.

Cellular Plastics in Aircraft. Carrol C. Sachs. The possibility of utilizing cellular boards as core material for structural sandwich construction in aircraft is considered. The various types of thermoplastic cellular materials are classified on the basis of the type and characteristics of the blowing agent used in their manufacture, and their production is discussed. Other sections consider the thermosetting foams, copolymer foams, the physical properties of cellular materials, and the application of cellular boards to sandwich construction. Tables show a production scheme for rigid plastic cellular materials, physical data on experimentally available cellular boards, and physical test data on sandwich structures. *Mechanical Engineering*, March, 1946, pages 233–236.

The Forming of Bakelite Laminated Sheet. Methods of pressing Bakelite into shape, which have been developed by Messrs. Bakelite Limited London, are described. Some examples of aircraft parts thus formed from Bakelite laminated sheet are illustrated. The parts are formed in molds in a hydraulic or other type of press. *Engineering*, March 15, 1946, pages 248, 249, 3 illus.

Light Weight a Must in Aircraft. To provide an indication of future applications of plastics in aircraft, the writer outlines the experience of United Air Lines in equipping Douglas DC-3 and C-54 aircraft, taken over from the Army, for use as passenger and cargo planes. Investigations and laboratory work directed toward the use of greater quantities of plastics are described, with particular reference to acrylic windows, sound-deadening insulation, a flexible refrigerator, interior lighting fixtures, plastic plumbing, and airplane structural parts. *Modern Plastics*, March, 1946, pages 106, 107.

High-Strength Plastics in Future Aircraft Design. W. I. Beach. Existing limitations peculiar to the fabrication of reinforced thin-metal air frames, which include the difficulty of obtaining a very high strength-weight ratio, are pointed out. Possibilities for aircraft application of a process by which high-strength plastics are molded by methods commonly called "low pressure" are considered. It is stated that the process is flexible and lends itself readily to the construction of complicated shapes, open or closed, which would be impossible or at least unfeasible economically to duplicate by other methods, such as metal fabrication. In addition, the fact that low-density core materials can be combined with the faces of high-strength reinforced plastics to form sandwich-type panels makes the low-pressure process extremely useful in the production of aerodynamically clean and lightweight structure so necessary for efficient operation of aircraft. Statistics are supplied about the relative properties of high-strength corded plastics and aluminum materials. A design and stress analysis is made of a plastic counterpart of a metal outer-wing panel. *Mechanical Engineering*, March, 1946, pages 225–232, 4 illus.

Private Flying

The Urge to Fly. E. C. Bailly. A consideration of the psychological aspects of the desire to fly. It is stated that while greater numbers of people are being gradually attracted to flying, each individual case presents obstacles. Since nonfliers are faced by numerous discouraging factors, it is an obligation of the promoters of aviation to try to meet them halfway and cut down these barriers as much as possible. The writer discusses flying as a career, the advantages and limitations of flying for business transportation, and refutes some of the fallacious arguments against flying for the average citizen, including the misconception that flying a light plane requires exceptional physical abilities. *Air Facts*, April, 1946, pages 61–67.

A Private Owner to Private Owners. F. G. Miles. Comments are made on the position of the private flier in England today. The Managing Director of Miles Aircraft Ltd. offers answers to the following questions: whether the private pilot can purchase an airplane; how much gasoline he can obtain; what licenses are necessary to fly a personal aircraft; where the private pilot can fly; what the situation is with regard to airplane clubs and the cost of instruction; how the cost and quality of the airplane compares with prewar standards; what servicing, storage, and airport facilities are available; and what types of aircraft are obtainable. *The Aeroplane*, February 8, 1946, pages 162, 163, 6 illus.

Selecting for Safety. E. S. Ewart. The detection during flight instruction of the accident-prone type of potential pilot, which is termed one of the major problems of postwar private aviation, is recommended. Practical objections to the application of tests used by the Army and Navy to the selection of private pilots are set forth. The advantages of flight tests for this purpose are described. Consideration is given to the effect on the instructional program of designing the flight test to select for safety. *Air Facts*, April, 1946, pages 71–81.

Aero Digest's Sampler Chart of Personal Aircraft. Carl F. Elliott. Characteristics and pertinent data relative to 49 American-manufactured personal aircraft are listed in a chart. This chart shows the following for each of the airplanes: price range; utility type; power plant; performance; fuselage, wing, and empennage types. Supplementary notes forecast the outlook for private flying in 1946, in terms of light-plane production. *Aero Digest*, March, 1946, pages 39–44.

Any Hope for the Private Plane? J. B. Hartfranft, Jr. The General Manager of the Aircraft Owners and Pilots Association states that needed research for developing light planes is being neglected by the aviation industry, the N.A.C.A., and the C.A.A. He comments that according to the Loening report and a survey made by A.O.P.A., private planes are going to be expensive, standardized, and with as few improvements as possible because the light-plane industry is following the so-called short-sighted policy of building prewar planes to meet current demands without planning improved models for long-range sales. The disadvantages of this attitude are stressed. A list of 18 desirable design and accessory improvements for light planes is given. *Flying*, April, 1946, pages 21, 90, 92.

Where to Refuel? D. P. Barnard. It is observed that the usefulness of private-owner aircraft should be materially increased by employing the existing motor-car gasoline servicing facilities and, possibly, operating such aircraft on motor gasoline. To aid in weighing the pros and cons of this idea, the writer gives a brief résumé of the basic nature of gasoline. He considers the technical problems of gasoline distribution, which include those involving deterioration of the fuel itself, and those involving contamination by foreign bodies. He also points out that an advantage in the use of motor gasolines is that their volatility characteristics are seasonally adjusted to temperature requirements. Figures are quoted which indicate that, except in large cities, airports catering to private owners cannot support a system of gasoline

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servicing as complete as that now provided for the automobile. *Air Facts*, April, 1946, pages 21–28.

Which Plane Shall I Buy? William D. Strohmeier. The prospective purchaser of a personal airplane is advised about the factors to be considered in comparing one type of plane with another. Both as to performance and price range, the aircraft are classified in five categories: (1) the conventional, low-powered, postwar versions of prewar two-place light planes of the Cub type; (2) the two-control types, such as the Ercoupe and Skyfarer; (3) higher-powered, high-performance, low-wing, two- or three-place models, such as the Culver V and Globe Swift; (4) medium-priced four-place family and cross-country types, exemplified by the Stinson Voyager; and (5) higher-priced specialized types, like the Grumman Widgeon. Overall considerations are summarized as follows: (1) take-off and landing characteristics, plus the angle of climb; (2) performance characteristics with full load; (3) cruising speed; (4) vision range; (5) comfort; (6) baggage and extra equipment allowance; (7) flight characteristics; (8) cost; (9) type of construction; (10) serviceability; (11) reliability of the dealer. *Skyways*, April, 1946, pages 42, 43, 92, 94, 8 illus.

Production

Forming Heavy Plate with Kirksite Dies. L. R. Pistoles. To reduce the cost and expedite the fabrication of experimental forming dies for aircraft propeller blades, an investigation was made of alloys which could be cast to size. Objectives included the elimination of the machining process known as Kellering and the obtaining of a die material tough enough to form a limited number of experimental propeller blade plates of 1/2-in. thick SAE 4330 nickel-chromium molybdenum alloy steel. The article explains how Kirksite was found to meet most of the requirements, and how the operation was carried out. *The Iron Age*, March 14, 1946, pages 74, 75, 4 illus.

Magnesium Die Castings. Part II. Ralph M. Heintz. The second part of a serial article on the die casting of magnesium, by the Vice-President and Secretary of Jack & Heintz, Inc., discusses short cuts and techniques used to improve die-cast parts. Examples of magnesium parts that required ingenuity in casting are illustrated and described. Among these are a cylinder unit of a servo for an automatic pilot, which has wrought magnesium tubes die-cast into the magnesium body; a cylinder for a rocket-bomb servo in which a nitrided steel sleeve is die-cast in place; a gyro housing and cover that is die-cast extremely thin and corrugated in shape, to provide extra flexibility; and an oil pan into which are die-cast two pump housings, ports, baffles, passages, and a filter mount. *Machine Design*, March, 1946, pages 111–115, 13 illus.

Controlled-Stage Process Finish-Forges Turbojet Blades. C. E. Wilderman. A forging method is described by which rotor and compressor blades for aircraft gas turbines and jet engines are produced from heat-resistant alloys. Developed by Utica Drop Forge & Tool Corporation, this process is based upon carefully controlled heating and atmosphere, combined with accurate timing of each operation. It is credited with producing blades having a high degree of accuracy, as well as essential smoothness of finish. Surface dimensions are said to be sufficiently accurate for the blades to be considered as ready for final assembly after dressing front and back edges. Control of the heat cycles is achieved with recording instruments that provide continuous and permanent control data on conditions at every stage of the process. *Aviation*, March, 1946, pages 81–83, 7 illus.

Production Principles for Deep Drawn Magnesium Parts. Ralph G. Gillespie. The drawing characteristics of the magnesium alloys are discussed and principles involved in the deep drawing of various kinds of parts made from magnesium alloy are reviewed. Emphasis is placed on the importance of properly heating the material and using dies designed to meet the requirements for magnesium. Particulars are supplied about lubricants for the dies and blanks, pressure speeds, the choice of the alloy, and the finishing of the parts. *Materials & Methods*, March, 1946, pages 701–705, 7 illus.

Illustration Courtesy Jack & Heintz, Inc.

Ingenuity in die casting is illustrated in this oil pan which has die-cast into it two pump housings, ports, baffles, passages, and a filter mount.

Pressure Die Castings in Aluminium Alloys. E. Carrington. A survey of the advantages and limitations of current types of machines for the die casting of aluminum alloys. The special qualities of work produced by these machines and problems connected with the die casting of aluminum alloy are described. The article also contains data on the steels used for dies and the different types of aluminum alloy used for die-cast parts. *Light Metals*, March, 1946, pages 152–162.

Subcontract Seafire. Production methods followed by the British firm of Folland Aircraft, Ltd., which during the war was engaged in the subcontract manufacture of aircraft components, are described. Information is supplied about the application of time-balanced assembly and graphic planning methods to the production of parts for the Spitfire and Seafire fighter planes. Methods of spar assembly and mainplane assembly are described. The whole of the work on the batteries of fixtures is planned and recorded in the form of a master plan or graph which shows the number of hours occupied for each stage of the work. *Aircraft Production*, March, 1946, pages 138–148, 23 illus.

Jet-Airplane Engine Parts Produced on High Speed Presses. The production by means of high-speed presses of drawn steel parts and assemblies for jet-turbine engines is described. Problems connected with the drawing of stainless alloy sheet are explained. It is emphasized that absolute control of the drawing speed is of primary importance. A feature of the press is an automatic, adjustable "slow-down" that takes place just before the punch makes contact with the work, almost eliminating the tendency for the punch to push through the blank instead of drawing it. This avoids shock which might harden the metal and safeguards against possible fracture of the metal at the beginning of the draw. Drawing operations on Inconel domes for gas turbines are detailed and illustrated. A picture of two 150-ton presses used for drawing jet-turbine parts is shown. *Steel Processing*, March, 1946, pages 178–180, 4 illus.

Permanent Mold Fundamentals. J. W. Wheeler. The early progress of the aluminum permanent mold process is outlined. Mold life, design limitations, and the economic advantages of this process over sand and die casting are discussed. Other subjects considered include methods of tool and mold manufacture, the selection and training of labor, reasons for metal losses, and the future possibilities of larger permanent mold light-alloy castings. The features of a vacuum-cast aluminum air-cooled cylinder head and a die-cast supercharger vane ring are illustrated. *Modern Metals*, March, 1946, pages 11–16. 12 illus.

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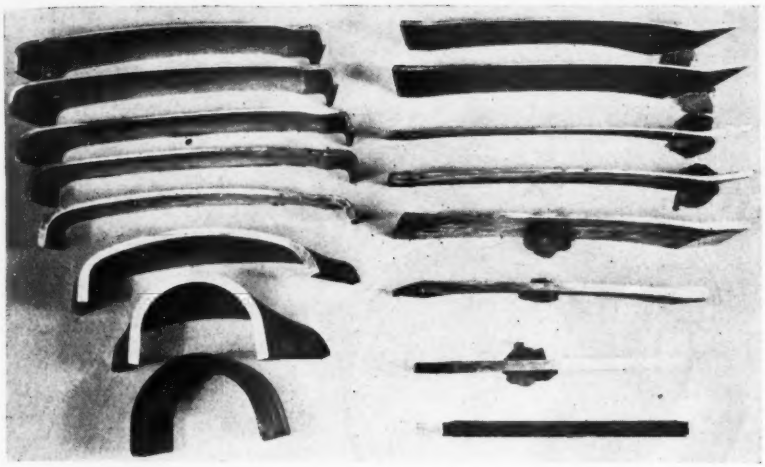

Illustration Courtesy Curtiss-Wright Corporation

In forming heavy plate with Kirksite dies the plate is subjected to severe loads. The illustration above shows sections of an experimentally formed aircraft propeller blade: (*left*) sections after forming and (*right*) sections through the plate prior to forming.

Propellers

Weight Reduction of Aircraft Braking Systems Through Use of Reverse-Thrust Propellers. Wendell E. Eldred, Henry H. Kerr, and Harold H. Warden. The results of tests conducted on a B-32 airplane to determine the weight-saving possibilities of reverse-thrust propellers are reported. It is stated that by applying reverse-pitch propellers to this 100,000-lb. aircraft a net weight saving of 407 lbs. was realized. Other advantages that can be obtained by the use of reverse-pitch propellers to assist in the braking of large, high-performance airplanes are outlined. To gain these advantages, proper techniques of landing must be used. The test program, the equipment and instrumentation employed, and the methods followed are described at length in sections dealing with the airplane, the brakes, and the propellers. *SAE Journal*, March, 1946, pages 107–119 (Transactions), 21 illus.

Radio

Evaluation of Night Errors in Aircraft Direction Finding, 150–1500 Kilocycles. H. Busignies. A paper first presented before the Institute of Radio Engineers in 1941, the publication of which was delayed because of wartime restrictions. It describes a method enabling pilots to determine the accuracy of night bearings obtained by radio compass in the frequency range of 150–1,500 kc. per sec. (200–2,000 meters) and the effects when the plane passes through the combination of fields resulting from reflections from the *E* layer or a mountainside. Elementary discussion is presented about the case of the night error on the ground and at altitude, considering the simultaneous presence of the direct wave, the sky wave, and the sky wave reflected from the ground. It is stated that the night error is smaller at an altitude than on the ground; also, there are certain altitudes at which the night error is reduced.

The dynamic aspect of the night error is then studied for a plane moving through the above-mentioned system of waves. How the radio-compass indication changes regularly about a mean value, whether correct or not, is next discussed. All cases of polarization are examined in an elementary manner in an effort to classify the numerous effects with which an experimenter may be confronted.

In conclusion, a number of rules are formulated relative to night direction finding on board airplanes above land or sea, supplemented by maps showing areas where direction finding is safe, unsafe, or dangerous. The maps show that the practical range of night direction finding is increased substantially by the correct interpretation of the radio-compass indications. *Electrical Communication*, March, 1946, pages 42–62, 17 illus.

What About VHF? Ken Lester. Comments are made on the advantages of very high frequency radio and its future in the field of private flying. Advice is offered about the characteristic behavior of V.H.F. electromagnetic waves and the operation of V.H.F. equipment for light planes. *Air Facts*, April, 1946, pages 29–38, 3 illus.

Reaction Propulsion

Jet Propulsion. William F. Durand. The Professor Emeritus of Mechanical Engineering, Leland Stanford University, and former Chairman of the Division of Industrial Research, National Research Council, clarifies the principles of jet propulsion and considers problems connected with the future development of jet engines. Factors that determine the propulsive efficiency and the thermodynamic efficiency are discussed. Directions in which research should be carried out to improve the jet engine are considered under headings referring to problems of combustion, construction, design, operation, and supersonic speed. The writer concludes that if the development of the jet engine may be compared with that of the present internal-combustion aircraft engine, an impressive future lies ahead for the jet propulsion unit. In its present state it is comparable with the piston engine of 40 years ago, and while it is futile to predict its detailed characteristics and performance 25 years hence, it will undoubtedly occupy an important place in the field of aircraft propulsion. *Mechanical Engineering*, March, 1946, pages 191–193.

Designing Ducting Systems to Gain Better Turbojet Performance. J. S. Alford. With the observation that well-designed air-induction systems for jet-propulsion power plants will yield great benefits through improved airplane performance, the writer shows certain useful relationships between duct design and pressure losses in the duct, with their consequent effects on performance. Setting forth the basic equation giving the net thrust of a turbojet unit, he applies calculations based on the magnitude of the air flow required to develop the desired thrust and suggests improvements in duct layout to reduce pressure losses. He explains the restriction factor and gives formulas for evaluating the air velocity and the losses at various points in the system. *Aviation*, March, 1946, pages 69–73, 6 illus.

V-2—And Beyond. Willy Ley. Part II of a two-part article on German rocket development concludes a description of research work carried on at the rocket institute at Peenemunde. It is stated that the Germans planned to construct a station in space outside the atmosphere. Further particulars are supplied about types of rocket weapons that were being developed. Research apparently directed toward the firing of V-2 rockets and possibly V-1 flying bombs from submerged submarines is discussed. Work that was being carried out to convert the empty V-2 into a glider is described. Details are given about the Wasserfall flak rocket, which was similar in conception to the long-range rocket. It is stated that essentially it was a smaller V-2 rocket. *Air Trails*, April, 1946, pages 36–38, 108–110, 2 illus.

Principles of Rocket and Jet Propulsion. Z. Krzywoblocki. Parts II and III of a series continue a discussion of rocket and jet propulsion principles. Part II deals with assisted take-off and landing. After a brief historical sketch of the subject, the writer presents short methods for calculating the force of the rocket necessary to shorten the take-off of

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Rocket to the Moon. R. L. Farnsworth. The problem of traversing the 240,000-mile gap separating the earth from the moon by means of a rocket is considered. Mechanical, physiological, and financial angles of the subject are discussed. *American Helicopter*, March, 1946, pages 19, 41.

Reconversion of Equipment

Royal Air Force Transport Modifications. The article deals with the modifications made to R.A.F. transport planes by the Transport Aircraft Modification Sections to convert or equip the airplanes as required by individual R.A.F. units. The number of conversions carried out on a standard airplane is exemplified by an account of the various modifications to which a Dakota may be subjected. Other Transport Command airplanes that are marked as undergoing modifications are the Lancastrian, York, Stirling, Halifax, and Oxford. *The Aeroplane*, February 8, 1946, pages 180, 181, 10 illus.

Research

CAA's Technical Development Laboratory. M. S. Gilbert. Some of the work that is being carried out at the Indianapolis experimental station of the C.A.A., where solutions to practical operating problems are being found, is described. Sections discuss research connected with radar, instrument approach-landing systems, fire tests, airport surfacing, lighting, and other activities. *Air Transport*, March, 1946, pages 51, 52, 55, 56, 5 illus.

The Shape of Planes to Come. Esther H. Forbes. This article reports on the functions and equipment of the research laboratories of the N.A.C.A. at Langley Field. It also outlines briefly the history of the N.A.C.A. and describes some of the trends in future airplane development which are indicated by the problems being worked on currently by the various N.A.C.A. laboratories. Special emphasis is placed upon the research being conducted for the furtherance of air travel at transsonic speeds.

The work of the following divisions of the N.A.C.A. research laboratories is described: Flight, Compressibility, Stability, Physical Structures, and Full-Scale Research Divisions; Aircraft Loads Division; and Hydrodynamics Division. As a result of the experimental work, some of the developments predicted as probable for the aircraft of the future are: longer, narrower fuselages; placement of the wings at a 45° angle to the fuselage; swept-back airfoils; proportionately larger tails; and the ability to withstand greater loads. The statement is made that airplanes capable of flying 1,000 m.p.h. are expected to be developed within 3 years. *U.S. Air Services*, March, 1946, pages 16–18, 1 illus.

The Future of Research and Development. Major Gen. Benjamin W. Chidlaw. Problems of future aeronautical research and development are discussed, it being emphasized that national security demands the greatest attention to aviation research. The importance of research and developmental activities of the A.T.S.C. at Wright Field is stressed. The transition from subsonic to supersonic speed is anticipated, and consideration is given to the possibility that swept-back wings may solve the compressibility problem. Problems connected with propulsion at supersonic speeds and gas-turbine control are outlined. Other sections deal with advances in ignition systems, future fuel requirements, the strategy of a future air war, radio and radar research, and needed aircraft operational improvements. *Mechanical Engineering*, March, 1946, pages 199–202.

Rotating Wing Aircraft

Flapping Characteristics of Rigid Rotor Blades. Ralph W. Allen. The influence of blade stiffness on rotor-blade flapping is investigated and equations are developed which describe the blade motion. The blade lag angle is also obtained and an example calculation is given. It is found that blade stiffness has a marked influence on blade lag and flapping amplitude and that there exists a possible resonant condition for the semirigid type of rotor blades. Increasing the blade stiffness decreases the magnitude of flapping and reduces blade lag. The stiffness effects are especially noticed in the transition from a freely hinged blade to a semirigid blade. *Journal of the Aeronautical Sciences*, April, 1946, pages 183–186, 3 illus.

Momentum Theorem. N. de Transche. Failures in the expected performance of helicopter rotors are examined in the light of the momentum theorem in its application to the theory and design of lifting propellers. It is stated that criticism is attributable to a lack of understanding of the formulation of the theorem and its application to propeller design. The theorems of momentum, moment of momentum, and kinetic energy are set forth and clarified. Assumptions that must be introduced are discussed. Mistakes in the interpretation of the momentum theorem are explained. *American Helicopter*, March, 1946, pages 9–11, 39, 40, 3 illus.

"The World with the Lid Off." Lawrence D. Bell. The President of Bell Aircraft Corporation comments on the advantages of the helicopter. He points out that the view from the helicopter is almost unobstructed, its controls are relatively simple, and its ability to land in a small area is of great value for many purposes.

Persons who suffer from air sickness experience considerable relief from helicopter travel because the helicopter rides smoothly even in turbulent air. *Aviation in Review*, February, 1946, pages 36–40.

Aeronautical Products' Model "3." A brief article describing the Model "3" helicopter, which has been designed and built by Aeronautical Products, Inc. A departure from usual helicopter design is that the engine is mounted at the front of the fuselage instead of at the center. It is claimed that the forward mounting allows the passengers to be placed near the center of gravity, provides for easy engine servicing, and simplifies cooling. The engine is a 155-hp. Franklin, mounted horizontally, and the three-blade main rotor is 30 ft. in diameter. The arrangement of the controls is described. *American Helicopter*, March, 1946, page 31, 2 illus.

One-Place Co-Axial 'Copter Completed by Roteron. The first model of a newly designed coaxial helicopter is described. Developed by Roteron, Inc., this helicopter is reported to have its 5-cylinder, 25-hp. radial rotary engine (with a 2:1 planetary gear reduction between crankshaft and upper rotor shaft) attached to the lower rotor hub. The entire assembly rotates freely in bearings. Torque of the upper rotor causes the engine case to counterrotate, consequently counterrotating the lower rotor.

Attention is called also to its control features and an arrangement that enables the pilot to vary the speed of the rotors. The completely enclosed fuselage is said to be of all-metal construction, using steel tubing and aluminum skin; landing gear is of the fixed tricycle type, with full-swiveling wheels; and the gross weight of the craft is 400 lbs. *Aviation*, March, 1946, page 53, 1 illus.

Stress Analysis

Effect of Bend Width upon Minimum Bend Radii. George Gerard. Bends of large width occasionally exhibit cracks at the center of the width when minimum bend radii successfully employed on small widths are used. An analysis of the stress condition existing at the center of a large width revealed an unfavorable biaxial tension stress that reduces the ultimate elongation from that in simple tension. An experimental photogrid strain survey on three aluminum alloys confirmed the results of the analysis and indicated the extent of biaxiality of stress as the width decreased.

Elongation data from standard tensile coupons were corrected for biaxiality, and the results were then applied in determining theoretical minimum bend radii for various widths of bend. *Journal of the Aeronautical Sciences*, April, 1946, pages 161–170, 17 illus.

Buckling of a Flanged Plate. Henry L. Langhaar. This investigation treats the buckling of an axially compressed isotropic elastic rectangular plate that is hinged on the ends, supported but subjected to elastic rotational restraint on one longitudinal edge, and flanged but otherwise free on the remaining edge. A numerical procedure with a rigorous mathematical basis is proposed for solving elastic stability problems of this type. *Journal of the Aeronautical Sciences*, April, 1946, pages 187–191, 3 illus.

A Method for the Stress Analysis of Helicopter Blades. Daniel O. Dommasch. The method of analysis presented is applicable to both fixed and hinged rotors. Although the equations developed apply directly to rectangular blades, the method may be extended to cover blades having other shapes.

Up to this time, no "exact" general solution has been found for even the simplest form of the differential equation governing rotor bending moments, although solutions can be determined for certain combinations of constants (these solutions are not general). Because of the lack of a general exact solution, various approximate methods such as series, perturbation methods, etc., were tried, but convergence was poor in most cases, necessitating the use of an unwieldy number of terms.

The solution presented in this paper is based on the method of finite differences and depends on the evaluation of a number of simultaneous linear equations. The method leads to a rapid determination of the bending moment at any point on the blade. *Journal of the Aeronautical Sciences*, April, 1946, pages 195–201, 6 illus.

Influence of Different Factors on Buckling Loads of Curved Thin Aluminum-Alloy Sheets for Monocoque Constructions. Georges Welter. Aerodynamic requirements of smooth surfaces and fair contours for both wings and fuselage have made aeronautical engineers conscious of the buckling problems associated with the design of semimonocoque (sheet-stringer) construction. This paper discusses the fundamental principles involved in increasing the buckling strength of the sheet. Test results show a 50 to 70 per cent increase in ultimate buckling load obtained by changes in the configuration of the sheet, which resulted in more load being carried in the supported edges and less in the unsupported central region. Although several suggestions are made, the practical method of achieving the desired results is left to the ingenuity of the designer. As a sidelight, these tests emphasize the necessity for well-controlled end and side conditions if consistent results

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are to be obtained in panel testing. *Journal of the Aeronautical Sciences*, April, 1946, pages 204–208, 217, 6 illus.

Static Displacement and Coupled Frequencies of a Twisted Bar. R. J. Dunholter. The elastic body considered is a straight bar with constant rectangular cross section and an initial structural twist of θ (constant) radians per unit of length. The object of the paper is twofold: (1) to calculate the static displacement components $u(z)$ and $v(z)$ in the direction of the principal axes u and v at each section due to the uniform loads w_u and w_v also in the direction of the principal axes; (2) to approximate by the energy method, using the displacement functions mentioned in (1), the first two natural frequencies of the bar. The method used is applicable to any end conditions but only the fixed-free case is considered. In the case of a fixed-free bar without twist the two fundamental frequencies corresponding to vibrations normal and parallel to the minor principal axis v are given by the formulas

$$\omega_u = 3.52\sqrt{EI_v/\gamma L^4}$$

$$\omega_v = 3.52\sqrt{r}\sqrt{EI_v/\gamma L^4}$$

where $r = I_u/I_v$ and γ is the mass per unit length of bar. In the case of the bar with an initial structural twist these two fundamentals will be coupled. *Journal of the Aeronautical Sciences*, April, 1946, pages 214–217, 2 illus.

Stress Without Strain. Anthony A. Fletcher. A description of a simplified method of propeller-blade stressing, with particular reference to wood or "improved wood" blades. Simple solutions to bending-moment and centrifugal-force problems are suggested. *Flight*, March 7, 1946, pages 243–245, 7 illus.

Flutter of Propeller Blades. J. V. Inglesby. An analytic study of the flutter of stalled and unstalled propeller blades is presented. The flutter of unstalled propeller blades investigated is the unstable coupled flexural-torsional oscillation, while the flutter of stalled blades is assumed to be unstable torsional oscillation caused by aerodynamic hysteresis, which is Studer's theory of stalled flutter. A method of estimating critical speeds, which is within the scope of stress-office work, is proposed and examples are supplied. The observed and calculated flutter speeds of propeller blades are tabulated. *The Journal of The Royal Aeronautical Society*, February, 1946, pages 98–118, 4 illus.

Impact Stress in Elastic Bodies Calculated by the Energy Method. Merhyle F. Spotts. The application of the energy method to the solution of impact problems is explained. Fundamental force, moment, and energy equations are derived and used in equations for gravity acceleration and for calculating the stresses in bars and beams caused by the impact of moving weights. Torque equations also are derived for torsional impact in a rotating system. *Product Engineering*, March, 1946, pages 200–204, 12 illus.

Superchargers

Exhaust Ejector Improves Both Turbo Cooling and Propulsion. W. O. Meckley. As demonstrated by flight tests on one of General Electric's high-altitude "flying laboratories," a Douglas XB-23, the advantages of using an exhaust hood air ejector on a turbosupercharger exhaust discharge are explained. The objectives of the described ejector exhaust hood installation were twofold: (1) to produce a subatmospheric pressure between the turbosupercharger and enclosing shroud; and (2) to improve cooling, especially during ground operation and under climb conditions. It is claimed that the unit provided new operating economy and reliability by according greater efficiency in circulation of cooling air and adding 8 per cent in additional thrust. *Aviation*, March, 1946, pages 74, 75, 150, 151, 3 illus.

Testing Equipment

Stress Measurement by Electrical Means. Robert E. Kern and Sidney B. Williams. It is stated that the advent of electric strain gages suitable for the measurement of mechanical performance on a strength basis not only has widened the field of the electrical engineer with regard to equipment and techniques but gradually has imposed upon him a responsibility to the aeronautical or mechanical engineer in his role as interpreter. The writers then endeavor to present the strength evaluation problem broadly enough for one working in a relatively narrow element of it to appreciate the requirements of the whole. Emphasis is placed on electrical aspects of the subject. The mechanical problem is discussed in the first part of the paper in sections dealing with design, electrical measurements, the bonded wire gage, the stress gage, and errors of location and installation. Electrical problems are then reviewed in sections concerned with gage circuits, special circuits, and the selection of instruments. *Electrical Engineering*, March, 1946, pages 100–106 (Transactions), 6 illus.

Tools and Equipment

Controlled-Cycle Centerless Grinding. The article provides details about a new centerless grinding machine introduced by Arthur Scrivener, Ltd., Birmingham, England. Incorporated in the machine is a patented "controlled cycle" method of operation which permits deeply formed pieces to be ground and ejected automatically without difficulty. In plunge-grinding with this machine, the advance of the control wheel and work to the grinding wheel, the removal of a certain amount of stock at a predetermined rate, the ejection of the finish-ground piece, and the opening of the wheels for the reception of the next piece are all performed automatically at any rate up to 1,000 complete cycles per hour. *Aircraft Production*, March, 1946, pages 129, 130, 6 illus.

Wartime Developments in British Machine Tools. J. A. Oates. The writer describes some of the outstanding machine tools that were developed by the British for the quantity production of aircraft and arms with the use of unskilled labor under war conditions, but which are readily adaptable to normal peacetime uses. These include a three-spindle boring machine that was especially developed for machining the 260-lb. magnesium landing-gear bridge casting for the Halifax bomber; several machines used in the production of aircraft gears; and machines for profile turning and thread production. *The Iron Age*, March 14, 1946, pages 61–67, 12 illus.

Special Rivets for Shear Loading. Kenneth Schmidt. The article supplies specific data with regard to a new type of rivet which has been developed for applications where shear loads are large and tensile loads are small. Available sizes, dimensions, strength, and methods of driving and removing the rivets are noted. One illustration shows the rivets being used in the fabrication of a P-51H engine mount. *Product Engineering*, March, 1946, pages 236–238, 7 illus.

Training

The G.I. Gets Flight Training. John A. Macdonald. It is explained how veterans of World War II can obtain flight training under the educational phase of the "G.I. Bill of Rights." In addition, arrangements made by airport operators in the northeastern states to facilitate this training for veterans are outlined. *Yankee Pilot*, March, 1946, pages 8, 9, 22.

Lightplane Preflight. Elmer S. Bendiner. Evaluating the Link Trainer as too intricate for the task of familiarizing young schoolboys and schoolgirls with the "feel" and operational fundamentals of an airplane, this article describes a new device being developed by the Link company for preflight instruction. Instead of a fighter plane's panel and hood to create the conditions for instrument flight, the new unit is based upon a simple cockpit, unhooded, with the fewest possible instruments. It is expected to have accurate flight characteristics, to simulate closely the control responses of light planes, and to sell for less than $1,000. The article also contains brief data about another preflight trainer conceived

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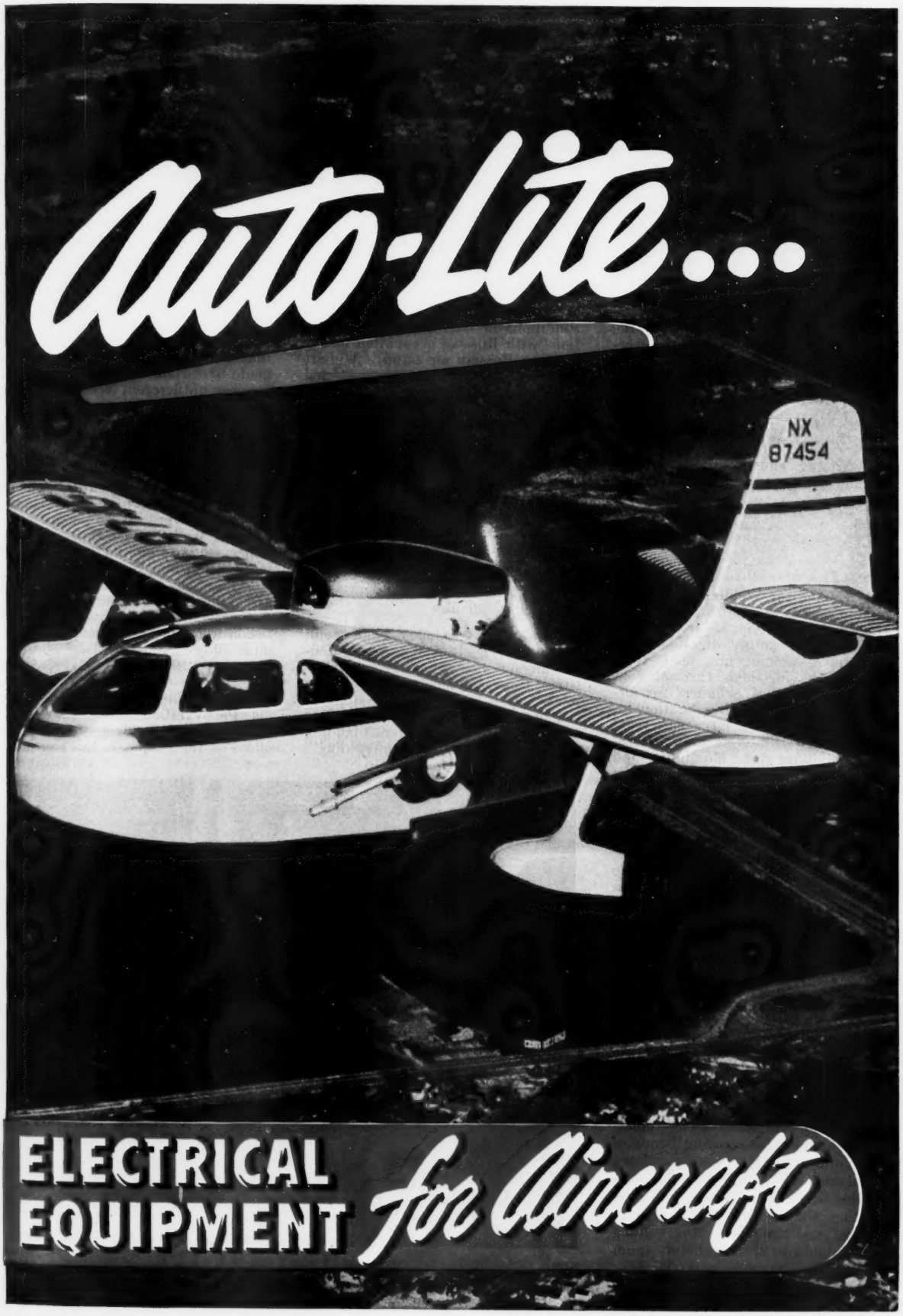
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by John Geisse of the C.A.A. *Flying Age*, April, 1946, pages 22–24, 56–58, 9 illus.

Training Junior Draughtsmen. D. Wakeford. It is observed that between the two World Wars little attention was paid to the training of draftsmen for the British aircraft industry and, in consequence, great difficulty was experienced by the drawing offices during the second war. Details are supplied about the training school for aeronautical draftsmen which was opened by the Fairey Aviation Company, Ltd., in 1943. It is explained that the method of training employed is intended to supply a solid foundation of knowledge on which future learning can be based. The syllabus is outlined and the method of explaining the manufacturing processes to the students is described. *Aircraft Production*, March, 1946, pages 149, 150, 2 illus.

Warfare

Disarming and Policing. John Yoxall. A report on the current strength and activities of the R.A.F. in Germany. The work of three specialized elements of the British Air Forces of Occupation's disarmament division is noted. These include the one dealing with the disposal of German aircraft and materials, the one handling the disbandment and control of Luftwaffe personnel, and the one responsible for the destruction of the antiaircraft artillery. With regard to the policing side of the R.A.F.'s functions on the Continent, the past record of Fighter Squadron No. 33—in charge of the Berlin sector—is mentioned along with its present duties, equipment, personnel, etc. The article also contains some observations on general conditions in Germany, R.A.F. relations with Russian occupation forces, and the Russian air setup. A chart demonstrates the organizational scheme of the British Air Forces of Occupation. *Flight*, February 7, 1946, pages 136–140, 13 illus.; "The Last of the Luftwaffe," by L. Graham Davies, *The Aeroplane*, February 8, 1946, pages 164, 165, 1 illus.

Welding

A Method for Welding Sheet Aluminum to S.A.E. 4140 Steel. W. F. Hess and E. F. Nippes, Jr. Results are reported of an investigation of the problem of welding fins, made from material having high thermal conductivity, to steel cylinders for aircraft engines. The investigation involved a study of a large variety of different metals used as an intermediate metal between aluminum and steel for the purpose of securing a good bond both from the point of view of strength and thermal conductivity. The work was carried on in the welding laboratory of the Rensselaer Polytechnic Institute, Troy, N.Y. It was found possible to secure a satisfactory bond between aluminum and steel by electroplating the steel with a layer of silver of proper thickness. The welding equipment was then used to make a proper bond between the aluminum and the silver plating. In order to effect this bond, it was found desirable to secure a heat balance by means of a high-resistance insert between the electrode and the aluminum. It is stated that important information was obtained in reference to the effect of the welding operation on the properties of the steel, and suitable electroplating techniques for securing bonds of maximum strength between the plated metal and the steel. The report is divided into two sections, the first treating the bonding of aluminum to steel, and the second, the welding of aluminum to chrome-molybdenum steel. The second part includes methods for the avoidance of hardening, and seam-welding problems. *The Welding Journal*, March, 1946, pages 129-s–148-s, 29 illus.

Uniwelding Produces High Joint Efficiency. E. R. Proctor. Particulars are supplied about the characteristics of oxyacetylene pressure-welded joints. It is stated that the application of this method of pressure welding to the manufacture of aircraft landing gears, designated as "uniwelding," has consistently resulted in joints of 100 per cent strength in bending. The joints show no line at the welds and the grain pattern is complete. The absence of weld metal results in a saving in weight, and joints so welded respond to heat-treatment in the same manner as the parent metal. Photographs of the welding equipment and photomicrographs of joint cross sections are shown. *The Iron Age*, March 7, 1946, pages 46–51, 10 illus.

The Welding of Non-Ferrous Metals. Part VII (Continued). E. G. West. The use of carbon arc welding and other welding processes for joining aluminum and its alloys is discussed in a continuation of Part VII of an article on the welding of nonferrous metals. It is observed that little commercial use has been made of carbon arc welding for this purpose until recent years, and even now the method is generally considered of value only in special cases. Reference is made to the application of automatic carbon arc welding to the fabrication of aircraft fuel tanks. Other processes that are discussed include automatic hydrogen welding, the multiarc process, argon-arc process, and Weibel and Rakos processes. Other sections pertain to the cleaning and finishing of aluminum welds, working the weld, anodizing weld assemblies, and the strength, corrosion resistance, inspection, and cost of fusion welds in aluminum and aluminum alloys. *Sheet Metal Industries*, February, 1946, pages 347–355, 10 illus.

The Welding of Non-Ferrous Metals. Part VII (Continued). E. G. West. The resistance welding of aluminum alloys is the subject of this continua-

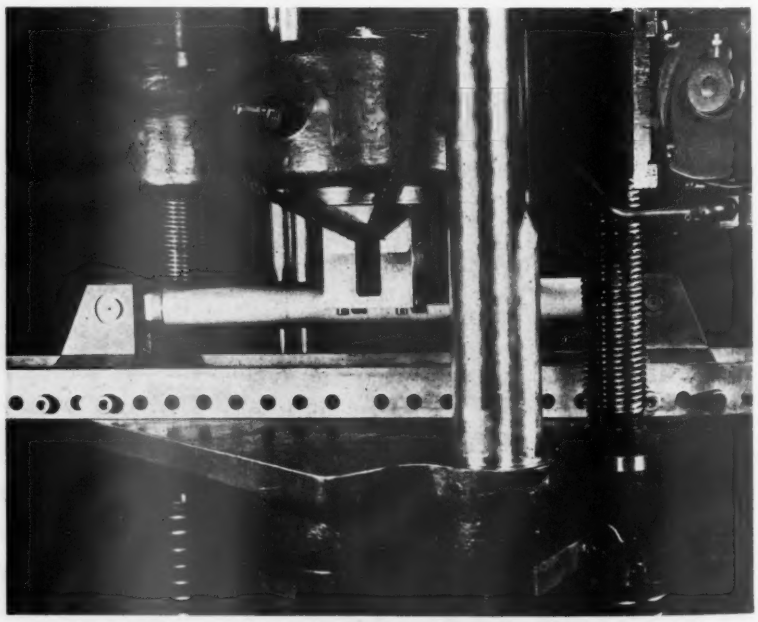

Illustration Courtesy Menasco Manufacturing Company

A welded specimen ready for testing on a Baldwin Southwark physical testing machine. Load is applied by means of a saddle as shown.

tion of Part VII of an article on the welding of nonferrous metals. It is noted that progress in this field of welding has been stimulated by the wartime demands of the aircraft industry. The specific requirements for the resistance welding of aluminum and alloys are outlined. The writer discusses the effect of the oxide film, current requirements, suitable welding machines, and metallurgic aspects of the subject. Particulars about the preparation of the surfaces of the metal to be welded are supplied. Prewelding treatments are compared. Other sections contain information about machine setting, cooling the electrodes, and cleaning and trimming the tips. Certain production data also are included. *Sheet Metal Industries*, March, 1946, pages 553–564, 9 illus.

An Investigation of Electrode Pressure-Cycles and Current Wave-Forms for Spot Welding Alclad 24S-T. W. F. Hess, R. A. Wyant, B. L. Averbach, and F. J. Winsor. A detailed report of an investigation that was carried out at the Rensselaer Polytechnic Institute, Troy, N.Y. It was undertaken with the following objectives: (1) to determine the relative merits of the constant electrode-pressure cycle and the variable electrode-pressure cycle in which the weld is made at a low pressure and then subjected to a higher "forging" pressure; (2) to obtain data pertaining to the time interval between current peak and application of the forging pressure; (3) to obtain data pertaining to the ratio of the welding to the forging pressure; (4) to observe the effects of varying the rate of current rise in condenser-discharge welding; (5) to study the effects of applying an a.c. preheat in condenser-discharge welding; (6) to study the effects of applying an a.c. postheat in condenser-discharge welding. The results and conclusions reached from the investigation are summarized. *The Welding Journal*, March, 1946, pages 148-s–162-s, 28 illus.

Resistance Welding. H. E. Lardge. Some of the results obtained from the application of resistance welding to stainless steel, Inconel, and nickel-chromium alloy are reported. The study was made as part of an investigation of problems connected with the development of sheet-metal structures working at high temperatures, such as gas-turbine combustion chambers, in which austenitic stainless steel and other heat-resisting alloys containing nickel and chromium are used. In such structures vibratory stresses also may be present and these increase the need for welds of a consistently high standard. Metallurgic factors and the welding technique involved are discussed. Microsections of welds are shown, together with welding data and the results of physical tests. *Aircraft Production*, March, 1946, pages 107–113, 18 illus.

The Development of Welding for Maintenance Needs. C. W. Brett. Advances in the technique of welding which have enlarged its scope in the maintenance field are briefly described. An illustration shows a supercharger casing of a German airplane engine, which was repaired by welding, installed in an airplane, and flown in England for experimental purposes. *Aeronautics*, March, 1946, page 40, 1 illus.

Welded Gas Turbine Rotors. John F. Cunningham, Jr. Welding procedures used in the fabrication of gas-turbine rotors are described. It is noted that gas-turbine rotors are subjected to extremely high temperatures and relatively high loads, and therefore are subject to creep. The classic method of shrinking discs on shafts cannot be used because the discs would eventually loosen in their fits with the shaft. The only favorable method of fabricating rotors for this type of equipment was to assemble a number of discs into a rotor through some method of attaching the discs directly one to another. A review of various methods of fastening the discs together led to the adoption of the welding procedure described. *The Welding Journal*, March, 1946, pages 237–241, 12 illus.

Spraying Filler Metals on Brazed Joints. An article reporting the results of an investigation that was conducted by an aircraft-manufacturing company to determine the possible advantages of applying filler material for brazing by spraying. The bond areas and shear strength of sprayed filler-metal joints and the usual wire filler-metal joints are compared. *The Iron Age*, March 28, 1946, pages 52–54, 2 illus.

Miscellaneous

28th Annual Statistical Issue. In the current issue sections are allotted to general industrial data statistics about the automotive and aviation industries, and specifications.

The aviation section contains figures on aircraft production, aircraft acceptances and their air-frame weights, the production and shipments of aircraft engines, the value of aircraft and engine production, and operational statistics of air lines. Figures are supplied on the number of civil aircraft and pilots, and the number of airports, and there are tables of exports of aeronautical goods. Specifications are listed for American commercial and private aircraft, aircraft gas-turbine power plants, American and British aircraft engines, small gasoline power units, and American gasoline and Diesel engines. *Automotive and Aviation Industries*, March 15, 1946.

Banner Towing for Profit. S. L. Wartell. A fixed-base operator describes how advertising-banner towing can be made to provide an additional source of revenue. He explains the construction of suitable banners and the procedure for flying them. Diagrams show details of the lead pole, tail pole, and banner-tow hitch. *Aviation Maintenance*, March, 1946, pages 26, 27, 82, 4 illus.

Table of Coefficients for Double Quadrature Without Differences, for Integrating Second Order Differential Equations. Herbert Salzer. The table of coefficients accompanying the article can be used to calculate a function whenever its second derivative is known at equally spaced points. The coefficients were obtained by a double quadrature of the well-known Lagrangian interpolation formula. They cover the cases where the second derivative of the desired function is approximated by polynomials ranging from the second to the tenth degree, (i.e., for three-point through eleven-point formulas). They enable the user to determine the function itself at any one of the points where its second derivative is given, to within a given arbitrary value.

The chief use of this table will be to facilitate the numerical integration of second-order differential equations. The writer is connected with the Mathematical Tables Project, National Bureau of Standards. *Journal of Mathematics and Physics*, November, 1945, pages 135–140.

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Boeing XB-44 Super Bomber. A revised version of the Boeing Superfortress, the XB-44, with increased power and improved flight performance, has been announced by officials of the Air Matériel Command. This experimental model of the B-29 has been tested in flight since June, 1945, under the supervision of the Command and Pratt & Whitney Aircraft Division of United Aircraft Corporation. The production version, now being built by Boeing Aircraft Company at Seattle, will be known as the B-50 Superfortress.

Powered by four R-4360 Pratt & Whitney radial engines, the XB-44 has a total of 12,000 hp. The increase in horsepower over the B-29 comes from a change in the engine installation. The large increase in the available power provides a marked improvement in the take-off, rate of climb, and speed of the aircraft. Jet exhaust stacks give the airplane an increase in speed beyond that accounted for by the greater rated power of the engines. The airplane can be sustained in flight on less power than is available from one engine.

New nacelles have been designed for the XB-44 which enable a rapid change of engines. The new nacelle contains the engine, supercharger, induction system, oil system, and engine and propeller controls. This power unit can be quickly detached from the fire wall, permitting ready interchangeability. It formerly required the work of six men for 8 hours to change one engine on the B-29. Now, with the new power unit, the same number of men can do the job in $^1/_2$ hour.

The propellers have been replaced by four-bladed Curtiss electric propellers which have the reversible-pitch feature for braking purposes, and also a feature that permits the automatic synchronization of all four of the propellers. Although some more recent models of bomber aircraft have had this installation, the XB-44 is experimentally using this feature for tests to improve it. Automatic synchronization reduces the task of synchronizing the four propellers from a tedious job to a simple movement of a control knob.

The major external change on the XB-44 is that the air-scoop openings are at the cowl-flap line rather than

flush with the front of the cowling. The total nacelle length of the XB-44 is longer than that of the B-29, making the outboard, as well as the inboard, nacelle tips extend beyond the trailing edge of the wing. *Air Matériel Command.*

Jet-Propelled Photographic Plane. The Lockheed XFP-80A, an experimental version of the P-80 Shooting Star equipped for photographic work, is being tested in photographic flight experiments under the joint supervision of the Lockheed Aircraft Corporation, manufacturers of the plane, and the Air Matériel Command. The tests to date have shown that the plane facilitates the making of improved aerial photographs and promotes greater interchangeability of equipment.

Because of the lack of vibration from the jet engine, pictures have been taken from an altitude as high as 35,000 ft. and the results have been exceptionally clear. The jet installation in the XFP-80A affords such ready interchangeability from fighter to photographic plane that it can almost be called a two-in-one airplane. The removal of only four bolts in the armed nose of the P-80 permits the removal of the nose and replacement with the nose containing the cameras of the XFP-80A. This, in addition to the relatively simple job of connecting the camera controls within the cockpit, is all that is necessary to make the plane ready for flight as a photographic plane.

A problem presented by the great speed of the P-80 was that of assisting the pilot in procuring pictures of the area with which he was concerned. To meet that need, a new device called the View Finder was designed. That device is expected to be installed on the XFP-80A and will do its work in a manner similar to a bombsight. Its physical appearance can be likened somewhat to that of a submarine periscope. With the View Finder, no matter how great the flying speed, the pilot is able to determine, far in advance of taking the picture, that he has the particular area he wishes to photograph in the sights of the camera lens. *Air Matériel Command.*

The Mission, Functions, and Operations of the Atlantic Division, Air Transport Command, Army Air Forces. The Atlantic Division of the Air Transport Command is a specific example of the new peacetime organization of the Air Transport Command and of the Army Air Forces. In its new peacetime role, the mission of the Division is threefold and extends far beyond the operation of a through overseas military air line, its primary wartime mission. It now embraces command responsibility for all American troops at the Division's overseas bases and field implementation of U.S. military policy at these bases.

Aside from general problems of military command, control, and administration of overseas troops, the present problem of demobilization occupies a paramount position. Pursuant to War Department directives, this headquarters is responsible for demobilization and return of all U.S. Army troops within its jurisdiction both at home and abroad. Total personnel under command of Atlantic Division Headquarters consists of approximately 2,800 officers, 13,000 enlisted men, and 16,000 civilian employees.

In the field of national policy, the Atlantic Division is making a major effort to continue the development of regularly scheduled American military air transportation over a wide network of air routes. Further, domestically, it is taking extraordinary steps to make its techniques, development, and the results of its experiences available to American commercial carriers.

The Atlantic Division operates regularly scheduled military transport aircraft over an air line that extends down the east coast of the United States to Panama, through a group of Brazilian bases to Ascension Island, and across the South Atlantic to the west coast of Africa. It crosses the North Atlantic by several routes, including one by Bermuda and the Azores, another by Newfoundland and the Azores, and the third by Labrador and Iceland to Oslo, Stockholm, Paris, London, Rome, Cairo,

The Boeing XB-44, prototype of the B-50 Superfortress, with its interchangeable power-plant nacelles, is powered by a Pratt & Whitney Aircraft 3,000-hp. R-4360 Wasp Major. The rate of climb, speed, range, and load-carrying characteristics of the XB-44 are superior to those of the Boeing B-29.

and eastward through connections with other A.T.C. divisions in the Far East. The Division is at present operating 84 C-54 four-engined Douglas transports over 36,000 miles of international air routes on regular schedules.

The Atlantic Division comprises the North Atlantic Wing, which is primarily responsible for the operation of the military air line, and five overseas base commands whose primary responsibility is overseas military command and national policy. The headquarters at Fort Totten is responsible to the Air Transport Command for balancing activities of the subordinate commands and channeling such matters as must go to higher authorities back to Washington. The headquarters of the North Atlantic Wing, which operates the air lines, is at Westover Field, Chicopee Falls, near Springfield, Mass. U.S. Army forces in Brazil and Ascension Island are under the South Atlantic Wing with headquarters at Natal, Brazil. *Atlantic Division, Air Transport Command.*

Weather-Observation Flight Around the World. A B-17 Flying Fortress has completed a round-the-world, 34,000-mile flight seeking "the worst weather in the world." The Air Matériel Command converted the Flying Fortress into a "flying laboratory," equipped with special instruments for measuring the electrical proportion of the atmosphere through which the aircraft would fly and for studying the nature of electrical charges picked up by test antennas. Special cameras were also installed to permit the making of permanent photographic records of data obtained. In addition, voice recorders were installed so that the engineers might record other data not included on the film records.

Since thunderstorms are responsible for much of the radio static of weather origin, chief interest on the flight was in seeking out and flying through thunderstorms. Oddly enough, the worst thunderstorm static encountered on the 34,000-mile flight occurred within the United States, between Kansas City, Mo., and Indianapolis, Ind. Other severe thunderstorms were found on a run between Natal and Rio de Janeiro, Brazil.

Data obtained on the types and behavior of static will form the basis for further work by the Electronic Subdivision in developing devices to minimize static in radio receivers. Investigation into the causes of, and methods of eliminating or minimizing weather or precipitation static, has been under way for several years within the laboratories of the Electronic Subdivision. During World War II, most A.A.F. aircraft were fitted with static dischargers which served to carry off much of the static generated by a plane flying through snow, hail, ice, dust, and rain. *Air Matériel Command,* Wright Field.

Civil Aeronautics Administration

Civil-Aircraft Production in 1945. A rapid rise in the civil-aircraft production rate since V-J Day, from ten in July to 797 in December, is shown in statistics released by T. P. Wright, Administrator of the Civil Aeronautics Administration. Compiled by the C.A.A. Office of Aviation Information, which has taken over the wartime production-reporting functions of the Aircraft Resources Control Office, these first official peacetime production statistics show a total 1945 output of 2,047 aircraft.

This total includes only aircraft manufactured under C.A.A.-type certificates and does not cover experimental models. The prewar pattern was followed closely, with the two-place plane powered by engines ranging from 51 to 100 hp. accounting for 94 per cent of the total output. Production of the much-discussed family-size model was confined to one company, whose output amounted to eleven planes.

Although the production rate showed a sharp acceleration, from 39 in August to 401 in October and 797 in December, output must continue to advance rapidly if the industry is to turn out its announced goal of 30,000 planes in 1946. An average monthly output of 2,500 planes is required to reach this goal, which is based on reported orders on hand for 50,000 planes.

The 1945 production statistics are tabulated to show the number of each type of airplane and the percentage of each type produced. *Office of Aviation Information.*

Air Traffic Rules. A manual of 32 pages is issued as a supplement to Part 60 of the Civil Air Regulations. It deals only with those sections of Part 60 which pertain directly to air-traffic control and outlines in easily understandable form the procedures and phraseology for both airport and airway traffic control. Although the procedures and phraseology in the manual do not constitute regulations in themselves, they have been set up as recommended practices to provide for safety in operation of aircraft.

The manual is divided into three sections. Section I is designated as airport traffic control and gives general instructions with regard to taxiing, landing and take-off, traffic and taxi patterns; light-signal procedures for airport traffic control; and radiotelephone communication procedure and technique. Section II contains contact-flight rules with regard to flight plans, basic contact-flight rule minimums, and flight altitude. Section III deals with controlled flight encompassing contact flight rules, instrument flight rules, altitude requirements, air-traffic clearance, airway communications, radio reports, landing procedures, and other factors. Two pages of definitions clarify the terms employed. *Civil Aeronautics Manual 60.* For sale by the Superintendent of Documents, Washington, D.C., $0.15.

Air Marking. A revised edition of Civil Aeronautics Bulletin No. 12 contains suggestions for systems of marking airport locations, airways, and flight approaches. Information in the bulletin is based on a study and tests made over a period of years with such modifications and addi-

tions as have been found necessary through the actual construction of thousands of air markers and their observation under varying weather and light conditions. Descriptions are given of the nine general types of markers recommended for use as air-navigation aids, including combinations of letters and numerals showing not only the name of the community but its latitude and longitude and other salient features. The suggestions pertain not only to markers visible only during daylight but also refer to illuminated markers and the various types of construction that have been found suitable for their installation. Drawings and tables give recommended dimensions for the letters, numerals, and symbols, and keys for spacing them. A typical air map showing a section of the states of Iowa and Nebraska is inserted. *Civil Aeronautics Bulletin No. 12.* For sale by the Superintendent of Documents, Washington, D.C., $0.20.

An Analysis of Graphic Records of Pilot Performance Obtained by Means of the R-S Ride Recorder. Part II. Oscar Backstrom, Jr., and Morris S. Viteles. The second part of a study conducted at the University of Pennsylvania by means of a grant-in-aid from the National Research Council Committee on Selection and Training of Aircraft Pilots, from funds provided by the Civil Aeronautics Administration, presents a detailed discussion of quantitative techniques used in the evaluation of graphic records of flight performance secured by means of the R-S Ride Recorder. Records of the right 720° power turn of three standard flights, and of the left 720° power turn for the first and third of these flights, were projected at a magnification of 5 and scaled at an arbitrarily established time interval of 0.8 sec. The procedure gave measurements of the load factor or "vertical acceleration" trace, the left-wing-low trace, and the right-wing-low trace, from which were derived quantitative indexes of pilot performance. Graphic records for a total of 28 pilots, including ten primary C.P.T. students, ten recently licensed private pilots, and eight re-rated instructors, were analyzed in this investigation.

In all, 31 quantitative indexes were developed, descriptive of various aspects of pilot performance with respect to accuracy and consistency of bank, maintenance of lateral balance, and time consumed in executing the 720° power turn.

Intragroup differences between mean scores on the left and right 720° power turn were investigated for each of the three experimental groups (students, private pilots, and re-rated instructors) by means of tests for matched groups. Ten of the 31 quantitative indexes were employed in this investigation. Intragroup differences were also investigated with respect to slipping and skidding.

Intergroup differences among mean scores of the elementary students, private pilots, and re-rated instructors were analyzed by means of tests for unmatched groups. Each of the 31 quantitative indexes for both the right and left turns was included in this analysis. A preliminary investigation, employing four of the 31 indexes, was made to determine the value of using cutting scores for the differentiation of levels of flight experience. Lastly, a separate analysis was made of five of the 31 indexes to study the reliability of scores on flights flown in immediate succession. The results of these analyses are summarized. *Division of Research Report No. 55,* January, 1946.

A Study of Individual Differences among Flight Instructors in Making Spot Landings. R. Y. Walker, S. V. Bennett, and E. S. Ewart. A report is made of a study conducted at the Institute of Aviation Psychology, University of Tennessee, under the auspices of the National Research Council Committee on Selection and Training of Aircraft Pilots from funds provided by the Civil Aeronautics Administration and the Tennessee State Bureau of Aeronautics. The study, utilizing only five pilots, represents a preliminary investigation of individual differences among skilled pilots in making "spot" landings. A series of four experimental flights, consisting of take-offs and precision landings, were made by five experienced flight instructors in a specially equipped Piper Cub J-3 plane. Each subject made two series of flights: the first series "Without Tricks," during which slipping, "mushing," or other methods of altering the gliding angle of the plane were not allowed; and the second series with "Tricks Allowed," during which any procedure to increase the accuracy of the landing, within the limits of safe flying, was allowed, except the use of additional throttle. The "Tricks Allowed" condition resembles the situation under which precision landings are executed in the present private-flight tests in that intentional slips were permitted.

During these experimental flights data were gathered on a number of measures associated with flight proficiency. A number of these measures, in particular those obtained from the Ohio State Flight Inventory and from motion photographs taken of a concealed instrument panel, were relatively objective in nature. The data were analyzed by a study of variance procedures. The most important practical implications of this study are summarized. *Division of Research Report No. 56,* February, 1946.

Measures of Exercise Tolerance. Craig Taylor and Raymond Franzen. This report presents another of the early investigations undertaken under the auspices of the Committee on Selection and Training of Aircraft Pilots in the general area of problems concerned with the determination of the relationships between physiological response to exercise or stress situations and physical fitness.

Previous studies published in this series of reports have been concerned not only with the development of a maximized battery of physiological measurements for the prediction of particular work or stress situations, but also with the analysis of the predictive significance of these variables in terms of ability to learn to fly.

By and large these studies have shown (1) that the cardiovascular-respiratory responses to short exercise tests are not significantly related to flight proficiency; (2) that longer periods of measurement are necessary if a particular physiological function is to be reliably represented by the measurements recorded; (3) that within the range of "average physical efficiency" these measures are not discriminative; (4) that in order to get a valid measurement of physical response to exercise it would be necessary to standardize not only the physiological measures themselves but also to develop a criterion situation which would permit discrimination among individuals with respect to exercise tolerance.

The studies discussed in this report deal with (1) the development of a criterion test for the evaluation of exercise tolerance, (2) an analysis of existing standard fitness tests in terms of this criterion, (3) an analysis of the relationship between the cardiovascular-respiratory measures and this criterion, and (4) determination of the interrelationships among the physiological measures themselves.

The studies described in this report have served to indicate inadequacies of existing tests of physical fitness and the unreliability attendant in the physiological measures being customarily recorded as predictors of physical fitness. They have also suggested that a simple, easily administered, "submaximal" test that is under control of the examiner represents a practical means of assessing physical fitness. *Division of Research Report No. 57,* February, 1946.

A and E Training Information for Veterans. A "mechanic's information package" for veterans interested in aircraft and engine licenses is available without charge from the Office of Aviation Information, Civil Aeronautics Administration, Washington 25, D.C. The "package" is designed to provide complete and authentic information for servicemen desiring to secure jobs as aviation mechanics.

Included in the mailing are two booklets, *Aviation Jobs for Veterans* and *Employment Outlook in Civil Aviation,* information about the "GI Bill of Rights" in connection with on-the-job and school mechanic training, information concerning license requirements, and a list of approved schools for aircraft mechanics. *Office of Aviation Information.*

Radar Development for Civil Aviation. Future application of radar to the airways of the United States by the Civil Aeronautics Administration is now being expedited at the C.A.A. Experimental Station at Indianapolis. The first use of radar probably will be in air-traffic control. A scanning screen soon will be installed in the Indianapolis tower for use in approach control and landings and, when its value and technique are established, will be placed in traffic towers serving the most important airports along the 36,000 miles of airways.

The second use of radar commercially probably will be as a distance indicator in the airplane, a device by which the pilot will be told his exact distance in miles from his destination, or from an obstruction to his flight. While this is not "true" radar but more accurately an application of radio principles, it can be considered as a radar development

The third use now under study at Indianapolis has many problems connected with it and will need considerably more development. It is a radar collision-prevention device for use in the airplane to warn the pilot of approaching collision with other planes or objects on the ground. Today, the equipment for this device is too heavy and too costly for use by air transports, and its operation probably would require an additional member of an air liner's crew. In addition, more technical development is necessary.

Ability of radar to "see" planes and objects otherwise obscured makes it particularly valuable in air-traffic control, especially near airports where there is traffic congestion. A scanning screen will supplement the present method of "stacking" planes at 1,000-ft. altitude intervals, while the lowest plane is cleared by the tower traffic controller to come in and land. His ability to "see" the planes he is controlling will expedite this process and make it possible to bring planes in safely at 2- and perhaps 1-min. intervals.

Instrument-landing techniques by air liners also will be affected by radar. The present C.A.A. three-element instrument-landing system, in standard use by the Army during the war and on which hundreds of pilots have made thousands of "blind" landings, now is being installed at 100 major airports. It consists of the localizer which guides the pilot from 15 miles out along a straight line to the center of the runway, a glide path which guides him down at a safe angle to the surface, and two or more marker beacons which inform him of his nearness to the field. Substitution of the radar "ground-controlled approach" for this system is unwise at this time, C.A.A. engineers believe, and they are supported by air-line pilots. It will, rather, supplement the present system. The problem of substituting radar ground-controlled approach for the present method illustrates clearly one of the problems of air-navigation aid development. At present the Army's ground-controlled approach (G.C.A.) apparatus requires a crew of five men to operate it. In contrast, the C.A.A. system is automatic and requires only the services of the radar maintenance man at the airport where it is installed. To provide around-the-clock service would take at least four crews of five men each for every major airport where instrument-landing aids are required.

Tests of the G.C.A. equipment at Indianapolis will be conducted with aircraft of varying sizes to determine the manner in which large metal airplanes reflect radar pulses in comparison with smaller planes made of different material. Manufacturers of the equipment will participate in these tests. At the conclusion of these tests, accurate comparisons will be available of the radar and V.H.F. instrument-landing systems. *Office of Aviation Information.*

CAA To Take Over 200 Flying Aids. Civil Aeronautics Administrator T. P. Wright estimated that nearly 200 air navigation facilities installed in 68 countries by American military forces will be kept in operation for the benefit of U.S. international air commerce, under an Executive order giving the Department of Commerce such authority.

The War and Navy Departments have been operating at points outside the United States approximately 600 radio ranges, airways-communication stations, and similar facilities essential to safe air navigation. As the armed forces demobilized, the possibility was faced that many of these installations so necessary to safe civil operations on routes flown by American-flag air lines would be dismantled or abandoned. Anticipating this problem, the Air Coordinating Committee of the Federal Government directed a subcommittee headed by C.A.A. Deputy Administrator Charles L. Stanton to survey all such facilities and recommend a program to preserve those necessary to civil aviation.

The subcommittee found that 258 of the military installations are necessary to international air service, and 66 of these would be continued by military agencies in connection with occupation or similar duties. It recommended that the Department of Commerce be empowered to make necessary arrangements for continued operations of the remaining 192.

Under the President's order, the Administration can proceed in several different ways, according to the local situation. Where the country in which the facility is located desires to operate it, arrangements can be made through the State Department to give its nationals whatever training is necessary, and to operate the facility pending completion of such

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training. Where a nation does not desire to operate such a facility, negotiations can be carried on, through the State Department, for its operation by (1) the C.A.A., (2) a U.S. air carrier or other suitable U.S. private agency, or (3) by an international organization. The authority given the Department of Commerce does not cover landing fields built by U.S. forces, but applies only to "air navigation, air-traffic control, airways communication, and meteorological facilities." *Office of Aviation Information.*

Avigation. Training Handbook II contains a series of problems in air navigation and their solutions. The sections define vectors and how they are used, the wind triangle, interception, radius of action, and the navigational computer. The problems and the methods of solution are supplemented by diagrams and exercises to be worked out by the student.

A glossary and the answers to the problems are given at the end of the book. *Air Navigation Facility Operations Service Training Handbook II.*

Department of Agriculture

Forest Products Laboratory Bulletins. Additional bulletins in the series issued in cooperation with the Army-Navy-Civil Committee on Aircraft Design Criteria under the supervision of the Aeronautical Board and in cooperation with the University of Wisconsin are as follows:

No. 1339, Effects of Elevated Curing Temperatures on the Strength and Durability of Yellow Birch Plywood Joints Made with Room-Temperature-Setting Urea Glues. John M. Black and H. D. Bruce. Presents data obtained after a year of exposure of specimens of the described types of plywood to various conditions of heat and moisture.

No. 1535, Effect of Closed Assembly Time on Joint Strength in Gluing with Low-Temperature-Setting Phenol Resorcinol, and Melamine Glues. W. Z. Olson. Refers to work done in determining how various lengths of closed assembly time might affect the strength of joints between blocks when the temperatures at which the assembly is laid up and the pressures used in clamping the assembly are varied.

No. 1536, Durability of Glue Joints Between Blocks of Compreg and of Compreg and Wood. Herbert W. Eickner. Results of a study to determine the durability of glued joints in compreg and wood when aged under controlled conditions of moisture and temperature.

No. 1537, Durability of Room-Temperature-Setting and Intermediate-Setting Resin Glues Cured to Different Degrees in Yellow Birch Plywood. John M. Black and H. D. Bruce. A study performed to determine the minimum degree of cure of glues that will provide satisfactory durability in plywood joints.

No. 1594, Development of a Counterpart Vertical Fin of Papreg for the AT-6 Airplane. E. C. Jungmann. A report of the exploration of the possibilities of making primary aircraft structures of papreg, through the construction of a vertical fin for the AT-6A airplane, designed and fabricated from papreg and tested under static loads representing gust and steady dive conditions.

Other reports prepared by the Forest Products Laboratory with the cooperation of the University of Wisconsin are as follows:

No. R1489, Development of a Procedure for the Determination of the Properties of Cushioning Materials and Their Application in the Design of Cushions. Leon Lassen, Keith Q. Kellicutt, and W. J. Sanderson. Report of a study made at the request of the Air Technical Service Command for the purpose of (a) developing a rational procedure for the evaluation of the properties of cushioning materials for use in packages and (b) a procedure for the application of those properties to the design of cushions.

No. 1550, Methods for Testing and Evaluating Cargo Flooring for Transport Aircraft. M. P. Brokaw. Presents the results of an investigation made for the purpose of developing methods of testing and evaluating cargo flooring used in transport aircraft. The methods of test are described in detail and the results for ten types of flooring are shown.

No. 1551, Effect of Increased Moisture Content on the Shear Strength at Glue Lines of Box Beams and on the Glue-Shear and Glue-Tension Strengths of Small Specimens. W. C. Lewis, T. B. Heebink, and W. S. Cottingham. Contains the results of tests of box beams that were designed to fail by shear on the casein glue line between the yellow-poplar plywood webs and the Sitka spruce tension flanges. The tests were undertaken to determine whether or not a change in the strength of glue lines in shear or tension could be expected when the moisture content was greater at the time of test than at the time of fabrication.

Technical Note No. F-4 is a 3-page pamphlet dealing briefly with water-resistant glues suitable for wood working. *U.S. Forest Service, Forest Products Laboratory,* Madison, Wis.

Department of Commerce

General Theory of Equivalent Projections. Oscar S. Adams. General principles underlying map projections in which the area is preserved in constant ratio throughout the map are treated. Such projections are also called equal-area, and, sometimes, authalic projections. Suggestions are made, with the appropriate mathematical formulas, for solving the problems connected with the production of maps in accordance with the principles outlined, examples are explained, and the text is clarified by numerous tables and drawings. *U.S. Coast and Geodetic Survey Special Publication No. 236.* For sale by the Superintendent of Documents, Washington, D.C., $0.30.

Great Britain's Role in Civil Aviation Today. Ruth C. Leslie. The development and progress of civil aviation in the British Empire are analyzed by a member of the Commodity-Analysis Staff of the Office of World Trade Promotion of the Department of Commerce. The general subjects investigated are the ownership and control of British air lines, the services of the air lines in the linking of outlying portions of the Empire, and the wartime activities of the British air-transport companies. Figures are quoted to show the expansion in the service between the period 1941 and 1945, revealing substantial and consistent growth in the volume of passenger mileage, cargo and mail carriage, and service-aircraft mileage and flight time. Air routes operated in 1938 and 1946 are listed and compared, and an estimate is given of future services, both domestic and foreign. *Foreign Commerce Weekly,* March 30, 1946.

Magnetism of the Earth. Albert K. Ludy and H. Herbert Howe. The current edition of a publication issued originally in 1902 by the U.S. Coast and Geodetic Survey, and revised from time to time under different titles, is intended to give the essential facts about the subject to those who do not have the time or facilities for reviewing the entire field of published matter in that connection. The introduction reviews the importance of a knowledge of the earth's magnetism, magnets, and magnetic fields, and gives definitions of the terms used in dealing with magnetic instruments applied to surface and air navigation. The succeeding chapters deal with the earth's permanent magnetic field and its secular change; transient variations of the earth's magnetic field; magnetic surveys; instruments; origins of geomagnetic science. The 39 illustrations include charts of various parts of the world, charts of the earth's declination, pictures of navigation instruments, diagrams of celestial bodies, and several maps. *U.S. Coast and Geodetic Survey, Serial 663.* For sale by the Superintendent of Documents, Washington, D.C., $0.35.

Department of State

Air Transport Services. The text of agreements between the United States and other countries, and the exchanges of notes by which the agreements were made effective, are published in the form of pamphlets, one for each country with which such agreements have been concluded. Executive Agreement Series No. 457 refers to the agreement between the United States and Canada and Series No. 460 refers

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to a similar agreement with Ireland. *Department of State Publications Nos. 2363 and 2375.* For sale by the Superintendent of Documents, Washington, D.C., $0.05 each.

National Advisory Committee for Aeronautics

Stress Analysis of Columns and Beam Columns by the Photoelastic Method. B. F. Ruffner. Principles of similarity and other factors in the design of models for photoelastic testing are reviewed. Some approximate theoretic equations, useful in the analysis of results obtained from photoelastic tests, are derived. Examples of the use of photoelastic techniques and the analyses of results as applied to uniform and tapered beam columns, circular rings, and statically indeterminate frames, are given. It is concluded that this method is an effective tool for the analysis of structures in which column action is present, particularly in tapered beam columns, and in statically indeterminate structures in which the distribution of loads in the structures is influenced by bending moments due to axial loads in one or more members. *Technical Note No. 1002,* March, 1946.

Analysis of Deep Rectangular Shear Web Above Buckling Load. Samuel Levy, Ruth M. Woolley, and Josephine N. Corrick. A solution of von Kármán's equations for plates with large deflections is presented for the case of a rectangular shear web with height-to-width ratio of 2.5 to 1, reinforced by vertical struts having one-fourth the weight of the shear web. The results are compared with the solution of *N.A.C.A. T.N. No. 962* for a square shear web and with analyses by Kuhn and by Langhaar.

The computed shear deformation differed not more than 2 per cent from that for the square web. The stresses at the center and at the corners in line with the diagonal tension wrinkles and the force at the middle of the struts differed by not more than 30 per cent from that for the square web. Kuhn's analysis gave values of shear deformation and of stresses that were up to 37 per cent larger than those for the present analysis, and values for the maximum force in the struts that were smaller. Langhaar's analysis gave values for the shear deformations, stresses, and strut force that were generally much larger than those given by the present analysis; the differences were of the order of 50 to 400 per cent at the largest load. *Technical Note No. 1009,* March, 1946.

Extension of the Chaplygin Proofs on the Existence of Compressible-Flow Solutions to the Supersonic Region. Theodore Theodorsen. It has been known for some time that the velocity of sound is not the upper limit for potential flow. S. A. Chaplygin in his paper "On Gas Jets" (*N.A.C.A. T.M. No. 1063*) carried out some interesting proofs on the existence of solutions and gave proofs relating to maximums and minimums of certain functions. In the present paper these proofs are extended to include the supersonic potential-flow field adjacent to the subsonic region treated by Chaplygin. *Technical Note No. 1028,* March, 1946.

A Condition on the Initial Shock. Theodore Theodorsen. Initial shocks of the type that occur on airfoils at stream Mach Numbers less than unity are shown to satisfy a certain condition, namely, that the local Mach Number behind the shock wave tends to approach unity. This result is, in nature, similar to the classic condition of Kutta on the circulation.

A tentative theory is given for a special condition on the initial shock wave, which fixes a preferred shock as the one resulting in a local sonic velocity behind the shock front. *Technical Note No. 1029,* March, 1946.

Properties of Low-Aspect-Ratio Pointed Wings at Speeds Below and Above the Speed of Sound. Robert T. Jones. Low-aspect-ratio wings having pointed plan forms are treated on the assumption that the flow potentials in planes at right angles to the long axis of the airfoils are similar to the corresponding two-dimensional potentials. For the limiting case of small angles of attack and low-aspect ratios the theory brings out the following significant properties: (1) The lift of a slender, pointed airfoil moving in the direction of its long axis depends on the increase in width of the sections in a downstream direction. Sections behind the section of maximum width develop no lift. (2) The spanwise loading of such an airfoil is independent of the plan form and approaches the distribution giving a minimum induced drag. (3) The lift distribution of a pointed airfoil traveling point-foremost is relatively unaffected by the compressibility of the air below or above the speed of sound.

A test of a triangular airfoil at a Mach Number of 1.75 verified the theoretic values of lift and center of pressure. *Technical Note No. 1032,* March, 1946.

Wing Plan Forms for High-Speed Flight. Robert T. Jones. The purpose of the report is to show how the adverse effects of high speed may be minimized by the use of a relatively large angle of sweepback, so that the type of flow described in the Ackeret theory no longer occurs. It is shown that, in the case of an airfoil of infinite aspect ratio moving at an angle of sideslip, the pressure distribution is determined solely by that component of the motion in a direction normal to the leading edge. It follows that the attachment of plane waves to the airfoil at near-sonic or supersonic speeds (Ackeret theory) may be avoided and the pressure drag may be reduced by the use of plan forms in which the angle of sweepback is greater than the Mach angle.

The analysis indicates that, for aerodynamic efficiency, wings designed for flight at supersonic speeds should be swept back at an angle greater than the Mach angle, and the angle of sweepback should be such that the component of velocity normal to the leading edge is less than the critical speed of the airfoil sections. This principle may also be applied to wings designed for subsonic speeds near the speed of sound, for which the induced velocities resulting from the thickness might otherwise be sufficiently great to cause shock waves. *Technical Note No. 1033,* March, 1946.

New Supersonic Wind Tunnel for Research in the Problems of High-Speed Flight. Problems of flight beyond the speed of sound are being further systematically attacked by the N.A.C.A. in its new supersonic wind tunnel, reported to be the largest in the United States. The 1,500-m.p.h. wind tunnel, located at the Ames Aeronautical Laboratory of the N.A.C.A. at Moffett Field, Calif., is designed to operate exclusively above the velocity of sound. In the range of speeds above this natural barrier, until recently penetrated only by pilotless projectiles, tests will be conducted upon models of guided missiles and jet- and rocket-propelled aircraft. From this fundamental research will be obtained a knowledge of the design requirements for stable and controllable flight at the speeds made possible by recently perfected systems of propulsion.

Accurately made steel models are mounted in the 3-sq.ft. test section of the new supersonic tunnel. Air is forced through this constricted channel at as much as twice the speed of sound, simulating the conditions encountered by a supersonic aircraft. Power is provided by electric motors totaling 10,000 hp. driving four three-stage centrifugal compressors which rotate at a constant speed of 5,350 r.p.m. The heat generated in the compression of the air is removed by passing the air through large water-cooled radiators provided in the tunnel circuit.

Variation of the scale of flight is achieved by changing the pressure inside the tunnel from a near vacuum up to almost three times normal atmospheric pressure. Sensitive regulators maintain the pressure automatically at the desired value. In addition, the humidity of the air in the tunnel can be accurately controlled. Air driers permit reduction of moisture content inside the tunnel to as little as one per cent of that of normal atmospheric air.

Missile or aircraft models are supported in the stream of air on a slender boom extending from a balance that weighs the aerodynamic forces. Lift, drag, and pitching moment acting on the model are transmitted to springs whose deflections are measured by electric strain gages. Simultaneously, a sensitive optical appara-

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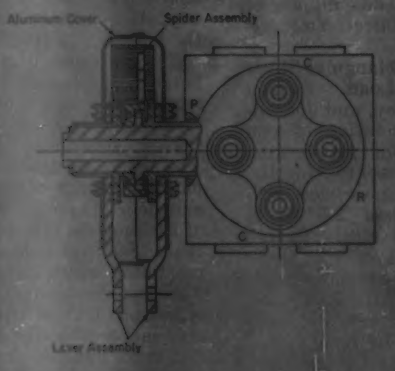

Two planetary gears are mounted on a spider fixed to the valve operating shaft. These gears are in mesh, and each meshes with a sector gear, free to rotate on the shaft. One sector gear is connected to the control lever, the other to the mechanism being controlled. Clockwise movement of the control sector causes opposite rotation of the planetary pinion in mesh with the second planetary gear, resulting in a counter-clockwise movement of the spider. This rotation opens the four-way valve permitting fluid flow to motor or cylinder. Since the unit being controlled is mechanically connected to the second sector gear, which also meshes with the planetary gear on the spider, movement of the controlled element tends to rotate the spider clockwise so that the valve is returned to neutral, thus locking the controlled element in the pre-determined position.

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tus permits the flow of air past the model to be observed and photographed. Details of the flow pattern visualized by this "schlieren" method provide a valuable aid in interpreting the numerical balance data.

Even greater speeds, up to the present foreseeable limits for guided missiles and aircraft, will be reached in another supersonic wind tunnel now nearing completion at the same laboratory. Complementing the present apparatus, it will extend the available range of supersonic testing speeds to an extreme of 3.6 times that of sound—more than 2,600 m.p.h. for short periods of time. Having a test section identical with the electrically powered tunnel to permit interchange of models, this "blowdown" tunnel will operate intermittently from a large pressure tank. All observations will be made within a period of about 10 min., in which time the entire supply of high-pressure dry air is exhausted to the atmosphere.

National Aeronautical-Research Policy. A National Aeronautical-Research Policy designed to insure maintenance of American air supremacy in the future, has been evolved as the result of a joint meeting of the National Advisory Committee for Aeronautics and the N.A.C.A.'s Industry Consulting Committee. The policy includes a clear-cut definition of functions of the major technical elements comprising American aviation, with the intent that maximum technical progress in aviation can be achieved through coordinated effort.

Fundamental research is considered the function of the National Advisory Committee for Aeronautics; application of research results in the design and development of improved aircraft and equipment, both civil and military, is the function of the aircraft industry; evaluation of military aircraft and equipment developed by the industry, and the exploration of possible military applications of research results, are considered to be the function of the Army and Navy; and the expediting of the practical use in civil aeronautics of newly developed aircraft and equipment, insofar as Government assistance may be necessary, is the function of the Civil Aeronautics Administration.

In establishing the importance of research to the many problems connected with civil aviation, the Aeronautical Research Policy states that it is in the public interest to foster a greatly increased civil use of the airplane, for domestic and international air lines and for private operation. A vigorous civil aviation can affect favorably the nation's domestic and international relations, both economic and cultural. At the same time, it will contribute to national security by the support of a reserve of airplanes; operating, development, and manufacturing facilities; and civilians trained in the skills that are critical in time of war.

Navy Department

Additional manuals used in Navy Training Courses, some of which have previously been restricted, are now available and are for sale by the Superintendent of Documents, Washington, D.C., at the prices noted.

Introduction to Airplanes reviews aviation history, aerodynamics, nomenclature of airplane structures, and power plants. It provides the enlisted man with a quick survey of some of the airplanes which are today making history. It takes up such matters as airplane handling, anchoring and mooring, aviation seamanship, cleaning and inspecting, fueling and starting. It includes a short discussion of aircraft armament and emergency equipment. *NAVPERS 10303, Bureau of Naval Personnel,* $0.40.

Hand Tools. The book begins with advice on the handling and care of such general-purpose tools as hammers, screw drivers, pliers, wrenches, and punches. It explains the use of shaping and cutting tools—chisels, hacksaws, files, and hand snips. The information about the tools used for soldering, drilling, reaming, thread cutting, tube fabrication, and for making measurements, is followed by a discussion of abrasives, which are important adjuncts to hand tools. *NAVPERS 10306, Bureau of Naval Personnel,* $0.30.

Fundamentals of Electricity. Beginning with static electricity, it presents a concise explanation of electronic theory and proceeds to the practical matters of circuits, Ohm's law, batteries, magnetism, generators, and motors. It concludes with the electrical applications found in sound apparatus. *NAVPERS 10311, Bureau of Naval Personnel,* $0.45.

Aircraft Metals. Commencing with a discussion of iron, the book follows with explanations about steel and its alloys, aluminum and its alloys, and copper and its alloys. It then describes hot-working processes, cold-working processes, heat-treatment of ferrous metals and heat-treatment of nonferrous metals. It concludes with a section on the physical testing of aircraft metals. *NAVPERS 10321, Bureau of Naval Personnel,* $0.30.

Aircraft Metal Work. Following a description of sheet-metal processes and the forming of aluminum, the manual continues with explanations concerning aircraft riveting, fasteners, structural repairs, repairs of tanks and tubing. A section on plastics is included. *NAVPERS 10323, Bureau of Naval Personnel,* $0.50.

Aircraft Hydraulic Equipment. The basic principles of hydraulically operated mechanisms are outlined, followed by a discussion of primary units, secondary units, and special valves. Attention is also given to the operation of hydraulic brakes, struts, and turrets. The hydraulic systems of four outstanding Navy airplanes—the Corsair, the Dauntless, the Avenger, and the Hellcat—are taken up in detail. In conclusion, there is a section on the maintenance of hydraulic equipment with special emphasis on trouble shooting. *NAVPERS 10332, Bureau of Naval Personnel,* $0.35.

Aircraft Fuel Systems contains information about tanks and tubing, fuel-line accessories, and fuel pumps. It explains the principles of carburetion, the kinds and uses of gasoline. It also describes the Stromberg float-type carburetor, the Stromberg injection carburetor, and the Holley carburetor. A section on the induction system includes intake manifolds and superchargers. *NAVPERS 10335, Bureau of Naval Personnel,* $0.60.

Aircraft Armament. The text tells how guns operate and explains various armament—the Browning machine gun and 20-mm. automatics, racks and shackles, and bomb-release systems. There is also a section on bomb-handling equipment. *NAVPERS 10341, Bureau of Naval Personnel,* $0.25.

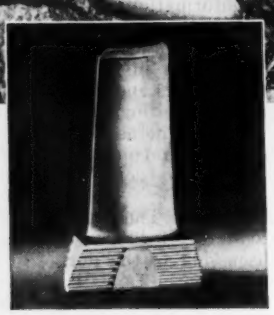
Aircraft Fire Control. Following basic information about the science of ballistics, the text reviews gun sights, boresighting, and synchronizing. This is followed by information about torpedo directors, bombing, and bombsights, concluding with a section on aerial gun cameras, aerial targets, and towing equipment. *NAVPERS 10342, Bureau of Naval Personnel,* $0.30.

Aerology. The material covers the introductory field of aerology. After a discussion of the purpose of aerology, it continues with explanations of temperature, humidity, precipitation, winds, clouds, and fog. It details information about weather codes, maps, and charts, and concludes with a description of the method for preparing records and maintaining the aerological office. *NAVPERS 10361, Bureau of Naval Personnel,* $0.60.

Mathematics. Beginning with a general statement of the basic principles of mathematics, the material offers a concise explanation of the use of whole numbers, fractions, decimals, and percentages. It gives a clear picture of directional angles, parallel lines, scale drawings, and triangles. It contains practical presentations of algebra, geometry, trigonometry, graphs, and logarithms, and concludes with an overall picture of measures of time and useful standard units. *NAVPERS 10620, Bureau of Naval Personnel,* $0.60.

Post Office Department

The Future of Air-Mail Transportation. At the request of the Postmaster General a study has been made to determine the facts relating to the transportation of a larger quantity of mail by air. The report includes: (a) various statistics concerning the effects that changes would have on



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the revenues and expenditures of the Department; (b) the possible establishment of an air parcel-post system; (c) data concerning the space and employees presently provided and used at existing air-mail field distributing offices; (d) the estimated number of employees and space requirements if all long-haul first-class mail were transported by air; and (e) information relating to possible reductions that can be made in the foreign air-mail postage rates.

The study was made as a guide to determine the question of desirability of recommending changes that could be made effective immediately and in the near future for the twofold purpose of (1) advancing the interests of business and the public by better postal service, and (2) to contribute materially and economically to the national defense by providing a major fleet of civilian planes and trained personnel through the increased use of aircraft in the transportation of the mails. The conclusions are set forth under eleven headings dealing with the feasibility of extending transportation of mail by air, and seven recommendations are made concerning the establishment of air-mail routes and the granting of authority for an expanded air-mail service. The text is supplemented by numerous tables, charts, and diagrams. *Office of the Second Assistant Postmaster General.*

Tennessee Bureau of Aeronautics

Tennessee Air Progress is a quarterly publication devoted to the development of aviation in the State of Tennessee. The Spring issue for 1946 contains articles outlining the state's program for aviation education; an article by T. P. Wright, Administrator of the Civil Aeronautics Administration, titled "C.A.A. at Controls as Aviation Guns Motors for Peacetime Progress"; a review of the activities of the Civil Air Patrol and the state's plans for feeder air lines.

U.S. Office of Education

How to Build Terrain Models. Instructions for the building of terrain models are given in a pamphlet compiled by the Navy Department for the Office of Education for use in the high schools. A large part of the methods of terrain-model building was developed by the Navy for use in combat. The building of terrain models is regarded as valuable in classroom work in such subjects as geology, botany, geography, history, and the social sciences. The practical applications of such skills are in flood control, water-power planning, soil conservation, and others including studies of air transportation. Prepared for the U.S. Office of Education by the U.S. Navy Office of Research and Inventions. *NAVEXOS P-296.* For sale by the Superintendent of Documents, Washington, D.C., $0.10.

War Department

Atlas of the World Battle Fronts in Semimonthly Phases to August 15, 1945. A supplement to the Biennial Report of the Chief of Staff of the U.S. Army, July 1, 1943, to June 30, 1945, contains maps and textual matter tracing the progress of the war effort in the two principal theaters of operation. The maps are arranged on facing pages to show simultaneous situations within the two areas. The successive maps record operations at half-month periods, showing graphically the advances within those short intervals, and permitting treatment of the major campaigns in detail. The maps are so colored that the principal Allied gains for each semimonthly period are shown in deep red, while areas under Allied control are shown in lighter tint. Enemy-controlled territory appears in white, while enemy gains during the period are shown in black. Neutral countries are colored gray. In the Pacific area, water routes between widely separated land masses furnished the key to the significance of territorial gains; to emphasize this characteristic ocean areas in the region of the advances are represented as zones of Allied control. The book contains 101 pages. *Army Map Service,* $1.25.

List and Index of War Department Publications. War Department Field Manual 21–6, dated January 10, 1946, supersedes a manual of similar number dated October 10, 1945. Its purpose is to provide an index to War Department administration, supply, and training publications, and a list of forms kept in stock at adjutant general depots. In addition to sections outlining the methods of numbering, the distribution plan, and ways of requisitioning such publications, the manual gives lists of training publications, technical manuals, field manuals, and other publications classified according to the branch of the Army to which they refer. Manuals for the use of the various air services are included. Other sections deal with administration publications, tables of organization and equipment, Army personnel classification tests, and a section outlining the rescissions, supersessions, and cancellations of earlier publications. *War Department Field Manual 21–6,* January 10, 1946.

A General Account of the Development of Methods of Using Atomic Energy for Military Purposes Under the Auspices of the United States Government. H. D. Smyth. An edition of the Smyth report has been prepared under the auspices of the War Department. It contains all the pertinent scientific information that could be released to the public at this time without violating the needs of national security. It gives, in general, the administrative history of the atomic-bomb project and the basic scientific knowledge on which the several developments were based. Not written as a "popular" account of the subject, the report is intended to be intelligible to scientists and engineers and to other college graduates with a good grounding in physics and chemistry. For sale by the Superintendent of Documents, Washington, D.C., $0.35.

Will There Be a Plane in Every Garage? is one of a series of pamphlets prepared for the U.S. armed forces by the American Historical Association, issued and made available by the War Department under the series titled "G.I. Round Table." They provide material that officers in the information and education branches of the service may use in conducting group discussions or forums as part of an off-duty education program, and which operators of the Armed Forces Radio Service may use in preparing GI Round Table discussion broadcasts.

The current pamphlet contains answers to a list of questions such as "Who will fly the plane of tomorrow?" "What will postwar planes be like?" and others dealing with the availability of ground facilities, the requirements for private pilots, and similar subjects. *G.I. Round Table EM 37.* For sale by the Superintendent of Documents, Washington, D.C., $0.15.

War Production Board

Production: Wartime Achievements and the Reconversion Outlook. The report to the War Production Board by J. A. Krug, at that time Chairman of the Board, reviews the accomplishments of the Board during the war and forecasts the progress of reconversion. The text is divided into two principal sections, the first containing a general summary of the activities of the civil population, and the second dealing with the individual problems of the principal industries of the nation. The text is supplemented by numerous charts, tables, and diagrams setting forth production figures and other statistics. Among the facts and figures of particular interest to the aeronautical industry are those concerning the production and supply of aluminum and magnesium, antifriction bearings, and internal-combustion engines, as well as other information regarding the production of materials, machinery, and equipment employed in industrial plants. *WPB Document No. 334,* October, 1945.

A Handbook on Wage Incentive Plans. The usefulness of and the results accomplished through wage-incentive plans are reviewed in a pamphlet of 39 pages. Following an outline of the reasons for such plans and their development, the various types of wage-incentive payments are studied, principles are set forth, and suggestions are made for the operation of such plans. *War Production*

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Board, Management Consultant Division. For sale by the Superintendent of Documents, Washington, D.C., $0.10.

Australian Council for Aeronautics

Sound in Wind Tunnels. G. K. Batchelor. Continued efforts to achieve an air stream of extremely small turbulence have now reached a stage at which the turbulent velocity fluctuations are comparable to the particle velocities produced by the noise normally present in a wind tunnel. The local pressure gradients produced by turbulence and noise are also of equal order of magnitude. A new property is thus required of low-turbulence wind tunnels—they must have a low noise level in the working section. This report draws attention to the new requirement and discusses the acoustics of wind tunnels.

The main aerodynamic sources of noise in a normal wind tunnel are the eddying flows accompanying the motion of the propeller blades and the motion of the air past the tunnel walls. Attention is given to the formation of resonant vibrations within a tunnel since a resonance may transform pressure variations into a high intensity sound. The calculated frequencies of stationary waves in the air columns formed by the different arms of an open-return tunnel are verified by experiment. A local example of sound radiation attributable directly to elastic vibrations of corner vanes, and indirectly to the vortex formation at the rear of the vanes, is described.

Various suggestions for the reduction of the noise level in the working section, both by reduction at the source of noise and by insulation from the source are put forward. In experiments involving a boundary layer critical to certain frequencies, removal of these frequencies from the tunnel noise can be achieved by the use of resonating side tubes.

In an appendix to the report, a mathematical discussion of the passage of a plane sound wave through an aerodynamic boundary layer shows that the condition of no slip at the boundary and the mean velocity variation near the boundary have little effect on the wave. The modifications to the sound particle velocity and pressure gradient along the wall are deduced. *Report ACA-18,* May, 1945.

Stress Analysis of an Engine Mount. F. S. Shaw and J. P. O. Silberstein. A method of analysis for engine mounts for the radial type of engine is derived. Its generality is restricted by the assumption that the mounting ring to which the engine is attached is rigid. The effects of the end conditions of the component members are investigated by considering two cases —pin-jointed and stiff-jointed.

The results of a numerical example —an analysis of an existing mount— indicate that, while the direct forces in the members are not sensitive to end conditions, the secondary stresses induced by the fixity of the ends are large. In the most highly stressed member the secondary stress raised the total stress by over 60 per cent of that attributable to direct force, whereas in the case of a lightly loaded member the stress increased by over 460 per cent.

The numerical example concludes with a brief discussion of the assumptions and their relation to the mount considered. The results are compared with those of a test carried out on the structure. It is found that the secondary stresses predicted by the theory attributable to rigidity of the joints agree reasonably well with the test results. *Report ACA-17,* May, 1945.

British Information Services

Design and Development of a Torsiograph Having a Serrated-Condenser Pick-up Unit. B. C. Carter and J. R. Forshaw. The instrument that forms the subject for this report has a condenser pickup unit to which a carrier wave is applied. It measures, directly, instantaneous angular displacements attributable to shaft twist. The pickup originated in a surface-strain gage (embodying serrated-condenser elements) which had been the subject of some preliminary experimental work.

Two main types of torsiograph are contrasted in relation to their application, and the present torsiograph is described. Results of calibration tests with different serrations and air gaps are given, together with a general account of experience gained during a total of some 10 hours of running with the instrument fitted to a Rolls-Royce Merlin II engine. Some typical records are included, but not the results of the torsional-vibration investigation, which will form the subject of a separate report. Calibration results are given from which the serrations appropriate to particular applications can be decided.

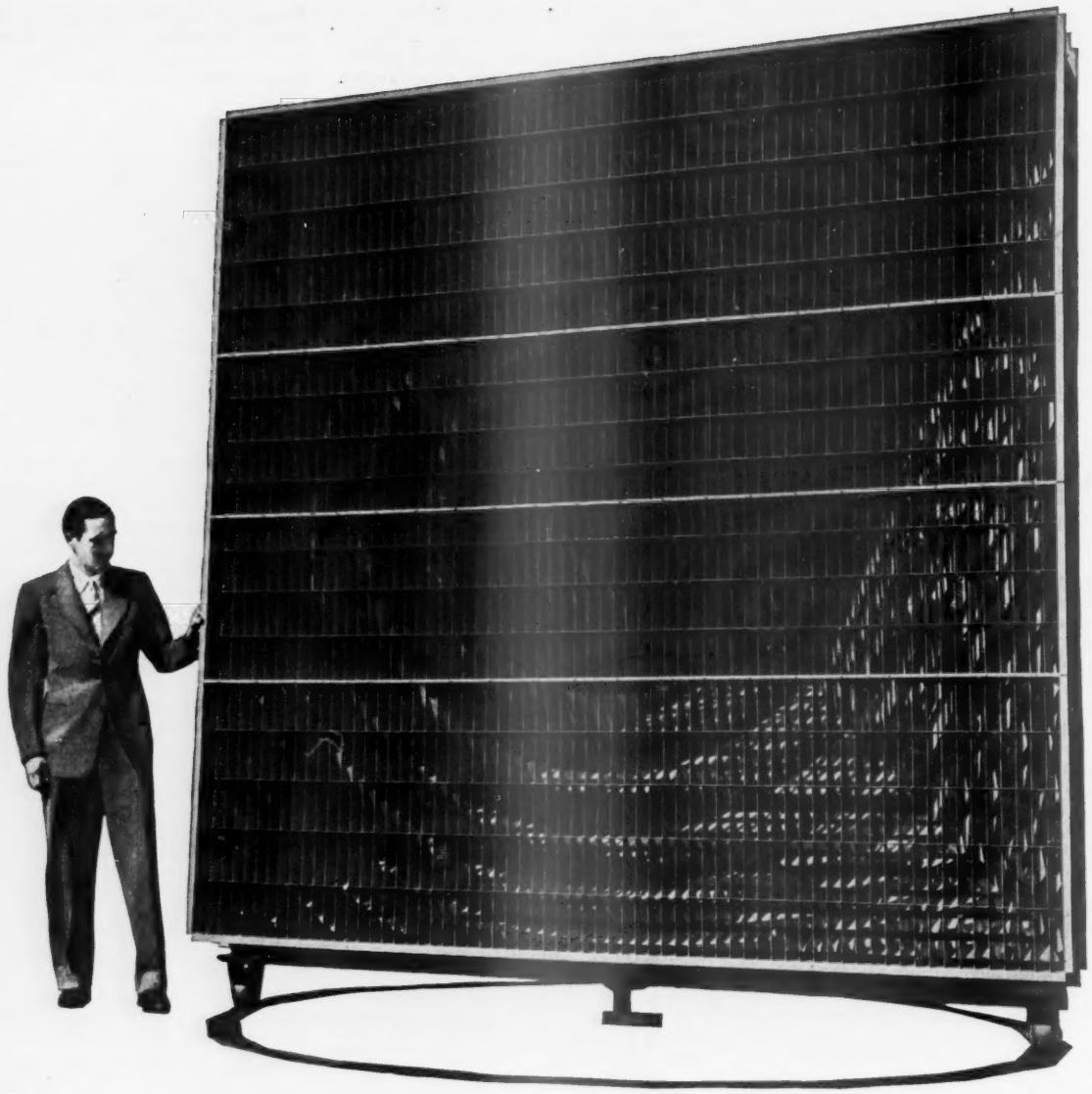
It is concluded that the torsiograph gives satisfactory results when due care is taken with electronic equipment. The natural frequency of the instrument is such that torsional vibrations having a frequency as high as 80,000 cycles per min. can be recorded with ease. The instrument provides a means for making continuous observations of torsional vibration at a moderately remote station and it can be adapted for making observations in flight. *Ministry of Aircraft Production, Aeronautical Research Committee R. & M. No. 1982.* British Information Services, New York, $0.60.

Effect on Hinge Moment of Fitting Strips Near Aileron Trailing Edge, of Increasing Aileron Chord and of Extending Aileron to Wing Tip. A. S. Batson and J. H. Warsap. The investigation was undertaken to find a method of modifying ailerons so that an airplane may be more responsive in roll. Hinge moment was measured on a 1/2:25 scale Hurricane aileron with the following modifications: (a) strips of a depth of 0.02 in. and of 0.04 in. were fitted near the controlling edge; (b) the aileron chord was increased from 18 per cent to 22 and 26 per cent; (c) the 22-per cent aileron chord was extended to the wing tips and strips having a depth of 0.04 in. also were fitted near the trailing edge. The range of the aileron angle was set at 0° to 15°, and the range of incidence was from −4° to 8°.

The pressures were measured over the surface of a control constituting 40 per cent of the chord of an NACA 0020 section airfoil of 30-in. chord, with and without strips having a depth of 0.05 in. to 0.20 in., or chords 0.09 in. in diameter, by means of static pressure tube. Angles of incidence were 0°, 4°, and 8°; and the control angles were 10° and 15°.

Slope of hinge moment—incidence curve (b_1)—and slope of hinge moment —aileron-setting curve (b_2)—are both increased negatively by about 0.2 when strips of about 0.8 per cent of aileron chord are fitted to the Hurricane aileron. These slopes are increased similarly when the aileron chord is increased, but by a little under half the amount. Extending the aileron to the wing tip also increases b_1 and b_2. In magnitude this increase in b_1 lies roughly between that due to fitting 0.04-in. strips, and that due to increasing the aileron chord from 18 per cent to 26 per cent. The value of b_2 is appreciably affected by gap at the nose.

Measurements of pressure over the surface of a control reveal the following facts: (a) Increase in magnitude of hinge moment due to strips is attributable to a boosting of pressure at and forward of the strip. This is considerable for a down-going (positive) control, but may be negligible for a small negative setting. (b) If the diameter of chords and the depth of strips are the same, and if the chords or strips are at the same fore-and-aft position along the control, the effect on hinge moment will be approximately the same. (c) The optimum position for the strip is at the trailing edge. (d) Hinge moment increases as depth of strip increases. (e) Only the strips on the pressure side of the control are effective: on a down-going control, a lower surface strip gives the same increase in hinge moment as both strips, while on an up-going control it reduces the effectiveness of the upper strip. *Ministry of Aircraft Production, Aeronautical Research Committee, R. & M. No. 1936.* British Information Services, New York, $1.05.



A "SEARCHLIGHT" TO FOCUS RADIO WAVES

In the new microwave radio relay system between New York and Boston, which Bell Laboratories are developing for the Bell System, giant lenses will shape and aim the wave energy as a searchlight aims a light beam.

This unique lens—an array of metal plates—receives divergent waves through a waveguide in the rear. As they pass between the metal plates their direction of motion is bent inward so that the energy travels out as a nearly parallel beam. At the next relay point a similar combination of lens and waveguide, working in reverse, funnels the energy back into a repeater for amplification and retransmission.

A product of fundamental research on waveguides, metallic lenses were first developed by the Laboratories during the war to produce precise radio beams.

This "searchlight" is a milestone in many months of inquiry through the realms of physics, mathematics and electronics. But how to focus waves is only one of many problems that Bell Telephone Laboratories are working on to speed microwave transmission. The goal of this and all Bell Laboratories research is the same—to keep on making American telephone service better and better.

BELL TELEPHONE LABORATORIES

EXPLORING AND INVENTING, DEVISING AND PERFECTING FOR CONTINUED IMPROVEMENTS AND ECONOMIES IN TELEPHONE SERVICE

Aircraft Engines of the World, 1946

Paul H. Wilkinson

Contents: Part I: Reciprocating-Type Engines; Standardized Data Pages; United States of America—Allison, Chrysler, Continental, Eclipse, Franklin, General Motors, Jack & Heintz, Jacobs, Kinner, Lycoming, Packard, Pratt & Whitney, Ranger, Warner, Wright; Great Britain—Alvis, Armstrong Siddeley, Blackburn, Bristol, de Havilland, Napier, Rolls-Royce, Rotol; Australia—Commonwealth Aircraft, General Motors-Holdens; Brazil—Fabrica Nacional de Motores; France—Béarn, Gnome-Rhone, Hispano-Suiza, Mathis, Renault; Spain—Elizalde; Sweden—Flygmotor; Switzerland—Saurer; U.S.S.R.—AM-38. *Part II:* Jet Propulsion Engines; Standardized Data Pages; United States of America—General Electric, Westinghouse; Great Britain—Armstrong Siddeley, Bristol, de Havilland, Metropolitan-Vickers, Power Jets, Rolls-Royce; Germany—B.M.W., Daimler-Benz, Heinkel-Hirth, Junkers, Walter, V-1. *Part III:* Miscellaneous; Engine Tabulations (Reciprocating); Index of Engines (Reciprocating and Jet).

Aircraft Engines of the World, 1946 edition, is the fourth annual printing of the international reference book devoted exclusively to aircraft-engine specifications. This year, information about engines built in Brazil, Spain, Sweden, and Switzerland has been added, and data referring to the engines of Italy and Japan have been omitted. German reciprocating engines are left out, but German jet engines are included. So much material has become available that the book has been divided into three parts. As in previous years, both English and metric systems of measurement are used. The content has been brought up to date as of the year of publication, and much of the material is exclusive.

Part I of this edition is devoted to reciprocating-type engines. It contains complete specifications of 104 of these power plants, and of this total, 70 engine pages (or 67 per cent) are new and 18 pages (or 17 per cent) contain major revisions. Of the 104 photographs used to illustrate these engines, 67 photographs (or 64 per cent) are new. Only three air-borne auxiliary units are included, of which one is new. Additional features, such as A.D.I. (alcohol-water or methanol-water injection) and boost pressures in pounds, have been added where needed. A tabulation of the high-powered engines of the various countries is included for comparative purposes.

With the exception of aeronautical annuals and books published outside the United States, books reviewed in this section may be borrowed without charge from The Paul Kollsman Library of the Institute of the Aeronautical Sciences, 2 East 64th Street, New York 21, N. Y.

Among the new reciprocating-type engines described in complete detail are the Allison V-1710-E23, -E30, -F30, -G3, and V-3420-B10; the Alvis Leonides LE-1M; the Armstrong Siddeley Cougar; the Béarn 6; the Bristol Perseus 100, Hercules 101 and 120, and Centaurus XI and 57; the Chrysler XI-2220; the Commonwealth Aircraft Merlin 102; the Continental A-100, E-185, GR-9A, and XI-1430; the de Havilland Gipsy Major 31 and 51, and Gipsy Queen 31 and 71; the Elizalde Tigre; the Fabrica Nacional de Motores R-760 and R-975; the Flygmotor DB 605 and STW-C3; the Franklin 4AL-225 and 6AL-335; the Hispano-Suiza 12Z and 24Z; the Jacobs R-755; the Mathis G4, G7, G8, G14, and Vega; the Napier Sabre VII; the Packard V-1650-9; the Pratt & Whitney Double-Wasp R-2800 C-series, and Wasp Major R-4360; the Ranger SGV-770 C and D series; the Rolls-Royce Merlin 24, 66, and 130, and Griffon VI, 69, and 130; the Saurer 12Y; the U.S.S.R. AM-38; and the Wright Cyclone 9 R-1820 HD series and Cyclone 18 R-3350 BD series. The new Jack & Heintz A2 auxiliary unit is also included.

Part II comprises 52 pages of information about jet propulsion engines. It includes 20 complete jet-engine specification pages covering turbojets, propjets, rocketjets, and pulso jets—all set up in standardized page form for the first time. The new names used to describe the various kinds of jet engines are explained in the text, and jet-engine activities in various countries are described. A complete tabulation of the jet engines of the United States, Great Britain, and Germany is given for comparative purposes. Many new photographs are used to illustrate these interesting power plants.

Among the new jet engines described in complete detail are the American General Electric I-16 and I-40; the Westinghouse Yankee 9.5, 19-A, and 19-B; the British Armstrong Siddeley A.S.X., Bristol Theseus, de Havilland Goblin II, Metropolitan-Vickers F2/4, Power Jets W2/700, and Rolls-Royce Welland, Derwent I, Derwent V and Nene; and the German B.M.W. 003, Daimler-Benz DB 007, Heinkel-Hirth He 011, Junkers Jumo 004, Walter HWK 509, and V-1. Brief details and photographs are given of other jet engines such as the General Electric TG-100 and TG-180 and the B.M.W. 003 R turbojet-rocketjet.

Part III contains a complete set of reciprocating-type engine tabulations presenting data of the latest aircraft engines of the United States, Great Britain, Australia, Brazil, France, Spain, Sweden, Switzerland, and the U.S.S.R. It also contains a complete alphabetical index of all of the engines in the book.

The author is a native American who has been connected with aviation since 1914. In England, he served his apprenticeship with the British Thomson-Houston Company Ltd. During World War I, he was with A. V. Roe & Company, Ltd., and the Royal Aircraft Establishment. In the United States he has been with the Boeing Aircraft Company and the Douglas Aircraft Company, Inc. During World War II, his aviation activities were with the War Production Board, the Board of Economic Warfare, and the War Manpower Commission of the United States Government. Paul H. Wilkinson, New York, 1946; 320 pages, $9.00.

The World of Wings and Things

Sir Alliott Verdon-Roe

Contents: The Albatross Glides Majestically; First Flying Prize; First Flight; Trials of a Pioneer; Brooklands Days; Military Trials; More Brooklands Days; The War—and After; 'Avro 504'; The Firm of A. V. Roe & Company, Ltd.; Men, Machines, and Memories; Many Inventions; The World of To-day and To-morrow; Views on Currency, Unemployment, Strife, and War; Down the Years—to What?; Flying On.

The autobiography of one of the pioneers of aviation, the founder of

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The all-important requirements of aircraft spark plugs are found to greater degree in dependable Champions than in any other spark plug. This follows from the predominant use of Champions by most of the airlines. But whatever the size of your aircraft engine, you'll feel it give smoother, more powerful performance with dependable Champions. Champion Spark Plug Company, Toledo 1, Ohio.

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INSTALL CHAMPIONS AND FLY WITH CONFIDENCE

the English aircraft-manufacturing firm of A. V. Roe & Company, Ltd., relates his experiences and gives his views of the future. A large part of the book presents an account of his early experiments and the reasons on which they were based, recounting the difficulties and obstructions that he encountered and the opposition that he overcame.

In an inscription on the inside cover of an autographed copy of the book Sir Alliott Verdon-Roe writes: "So long as we have to breathe and fly in an atmosphere reeking with humbug and hypocrisy to the extent that exists at the present time, not only civil aviation, but civilization will only be a mere shadow of its possible self."

During the past few years the author has been an advocate of a revision of the currency systems of the world. His ideas are given in detail in the concluding chapters of his autobiography. Hurst & Blackett, London, 1945; 270 pages.

Your Future in Aviation

Edited by J. Fred Henry

Contents: We Come of Age in the Air; Builders of Planes; The Men Behind the Machines; Busier Skyways; The Flying Team; The Ground Team; Uncle Sam Has Wings; Nests for Eagles and Sparrows; Money Makes the Props Go; Cracker-Barrel Hangars; A Pinch of Imagination; Air-Conditioning America; The Army and Navy Carry On; How Do I Find a Job?

With 6,000,000 men and women taking part in the military and industrial activities of aviation during World War II, it is predicted that 610,000 jobs will be available in postwar aircraft work. A writer of long experience has investigated the opportunities that will be open in airplane factories, in private flying, with the air lines, and in the services. He not only lists the jobs but quotes from the opinions about them of leaders in all aviation fields.

Returned veterans will find the chapters valuable as guides in determining the direction of their greatest usefulness. The jobs described are not those of war expansion but openings that will give thousands work in the great development of peacetime aviation. Prentice-Hall, Inc., New York, 1945; 329 pages, $3.00.

Fundamentals of Aviation

Norman Potter and William J. Konicek

Contents: Are You Ready for the Air Age?; History of Flight; Theory of Flight; Aircraft; The Aircraft Engine; Flight Technique; Civil Air Regulations; Navigation; Meteorology; Air Traffic Control and Communications.

Although prepared primarily for boys and girls interested in studying the fundamentals of aviation, this excellent textbook will be found equally useful by adults. The illustrations are so well drawn that they give the student the essentials of each part of an airplane, stripped of distracting backgrounds.

The text is clear and will be easily understood by readers of all ages. It is a worth-while effort of Edwin A. Link and should have a wide use in schools and libraries. Link Aviation Devices, Inc., Binghamton, N.Y., 1945; 107 pages.

Elementary Applied Aerodynamics

Paul E. Hemke

Contents: Units and Dimensions; Physical Properties of Air; Flow of an Ideal Fluid; Lift and Moment of an Airfoil in an Ideal, Two-Dimensional Flow; Three-Dimensional Flow Around an Airfoil; Induced Effects; Viscosity Effects; Airfoils and Their Properties; Compressibility Effect on Airfoil Characteristics; Propellers; Performance of a Conventional Airplane; Helicopters.

The author has prepared a book to meet the requirements of a first course in technical applied aerodynamics. It may be used conveniently in the time usually devoted to such a course in an average college term or semester. The material, with certain exceptions, has been presented in lithographed form for a number of years in the author's classes in aerodynamics at the Rensselaer Polytechnic Institute. The book is intended for students who have had preliminary training in mathematics, physics, and mechanics. In addition to the usual material, it contains certain topics generally found in more advanced courses. Among these is a more rigorous treatment of the stream function of an ideal fluid flow. A short chapter on compressibility effects and an introductory chapter on rotors and helicopters are included.

The material is presented in comparatively simple fashion, but the treatment is not merely descriptive where a fundamentally sound analytical treatment is desirable. Prentice-Hall, Inc., New York, 1946; 231 pages, $3.25.

Book Notes

Battle Report: The Atlantic War, prepared by Comdr. Walter Karig with Lt. Earl Burton and Lt. Stephen L. Freeland; Farrar & Rinehart, Inc., New York, 1946; 558 pages, $3.50.

The second volume of the "Battle Report" series tells the story of the Navy's war in the Atlantic, the Arctic, and the Mediterranean. The first volume told of the first 6 months of war in the Pacific. Volume Three will discuss the latter part of the war in the Pacific.

Throughout the report will be found accounts of the hazardous work of the aircraft carriers in antisubmarine action during the critical period when the enemy was sinking two tankers every day. Although the history is principally concerned with naval missions other than aviation, it does give a background picture of the services performed by airplanes from carriers and small airships over the Atlantic and Africa.

The book was prepared from official sources and records hitherto restricted facts. In an appendix there is a compilation of 3,500 decorations, awards, and citations for action in the Atlantic, European, Caribbean, Mediterranean, and North African theaters of World War II.

Eddie Rickenbacker, by Hans Christian Adamson; The Macmillan Company, New York, 1946; 309 pages, $2.75.

The life story of a boy who made himself a great automobile racing driver, the leading American Ace in World War I, and later an important figure in air transport would naturally interest anyone concerned with aviation. But Colonel Adamson has written more than a factual "Horatio Alger" tale of success; he has enlivened the biography with sidelights of Captain Rickenbacker's character building which will be a stimulus to many young men who are now starting life anew after war service.

Of particular interest to airmen of World War I will be the detailed story of the 94th Aero Squadron that shot down 69 German planes, including the 26 for which its leader received credit.

The charmed life that "Rick" has led by escaping from two serious airplane crashes is well known, but here it is told by one who went through the 24 days of the raft experience with him.

The book not only will be inspirational to many young men but adds a carefully written chapter to early military aviation history.

The Diary of a Postwar Correspondent, by Don Rose; Don Rose, Bryn Athyn, Pa., 1945; 34 pages, $0.50.

Reprinted from the *Philadelphia Evening Bulletin,* these articles by one of the best-known aviation writers tell of his visit to the European battle areas with several members of the Aviation Writers Association. They saw the ruined cities and dejected people, and in his impressions Don Rose brings the reader close to the devastation to be seen everywhere he

went. The newspaper style of writing makes the articles easy and interesting reading.

Navy Nurse, by Page Cooper; Whittlesey House, New York, 1946; 226 pages, $2.50.

The spirit that motivated the women who served as nurses in the Navy during the war is the thread that ties the chapters of this book together. The Navy Nurse Corps fitted itself into the Navy machine as an indispensable cog, but each member never relinquished that personal quality of service which is so important in the care of the sick and wounded men.

The story of the members of this helpful profession, which includes 11,000 volunteer nurses serving as commissioned officers in the U.S. Navy, will be read with interest not only by nurses but by many men who received their expert attention. An entire chapter is given to the training and work of the flight nurses.

Civilian Wings for Everyone; Shell Oil Company, Inc., New York, 1945; 40 pages.

The Shell Oil Company, Inc., has published a brochure that tells the prospective owner of a private airplane the essential facts he should know about operating and maintaining his personal plane.

It gives explanations of how an airplane operates, what must be done to qualify for a private pilot's license, and how to fly an airplane across country with the aid of the compass and flight charts. It will stimulate the interest of many in acquiring a small plane to use for pleasure or business.

Wings over One World; Air-Age Education Research, New York, 1945; 51 pages, $1.00.

The Town Hall Workshops in New York conducted a series of eight discussions on postwar aviation, sponsored by American Airlines System. Leaders in aeronautical thought participated, and excerpts from their talks are presented in this pamphlet.

The role and scope of American military aviation, the development of world air transport, the Chicago International Civil Aviation Conference, the prospects of commercial air transportation, personal flying, jet and rocket planes, helicopters, airships, and the outlook for the aircraft industry are some of the subjects discussed.

Ninth Air Force, USAAF; Executive Liaison Section, Headquarters Ninth Air Force, Washington, D.C., 1946; 48 pages.

The names of Brereton, Vandenberg, Strahm, Royce, Quesada, and Anderson will always be associated with the epic victories of the Ninth Air Force, which fought through the African and Italian campaigns, moved to England, and became an important element in the tactical accomplishments of the American and British Armies before the invasion of France. In the movement from the beaches of Normandy to Germany, the Ninth continued its varied missions. The story of its war career is shown almost entirely by means of sketches in color by Major Milton R. Marx.

To the French printer who produced the book for the Executive Liaison Section of the U.S. Army great praise is due for faithful color reproductions.

Trail Blazers of the Sky, by Frank Ross, Jr.; Wallace Hebberd, Santa Barbara, Calif., 1945; 169 pages, $1.50.

Accounts of the famous flights of airmen from that of the Wright Brothers at Kitty Hawk in 1903 to the first commercial transatlantic airline crossing in 1939. Illustrated by drawings by the author, the book makes an addition to the historical bookshelf of American aviation.

We Were Wasps, by Winifred Wood; Glade House, Coral Gables, Fla., 1945; 196 pages, $2.50.

The group of young women that Jacqueline Cochran organized in 1942, which became the Women's Air Force Service Pilots, made a valued contribution to the flying services of the Army during World War II. The story of their training and later work is told from the point of view of personal experience in this interesting

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During the War, a special feature is being made of reproductions and translations from the Foreign Technical Press

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book. The conversational style followed by the author makes for easy reading and allows humor, sarcasm, and praise to come naturally to the surface.

Although serving with the Army, the women pilots were denied Army status. They ferried planes of all kinds, towed targets, and served in dozens of other capacities. The book is not only about the WASPS but also is dedicated to them.

Radar: What Radar Is and How It Works, by Orrin E. Dunlap, Jr.; Harper & Brothers, New York, 1946; 208 pages, $2.50.

The development of radar is reviewed. The important part it played in World War II is described, and the uses to which it will be put in the arts and industries of peace are discussed. A simple description of how radar works is included. A glossary is provided to aid the reader in understanding the subject.

Teach Yourself Astro Navigation, by "Kaspar" (S. R. Millard); Published by David McKay Company, Philadelphia, 1946, for The English Universities Press, Ltd., London; 184 pages, $1.00.

By simple explanations and diagrams, the author presents the fundamental principles of astronavigation for marine and air navigators. The book is intended to serve as an introduction to the subject and to be useful to students in courses where a limited knowledge of the theory of astronavigation is required.

Bibliography on the Petroleum Industry, by E. DeGolyer and Harold Vance; School of Engineering, Texas Engineering Experiment Station, College Station, Tex., 1944; 730 pages.

Combined in this volume are Dr. E. DeGolyer's personal bibliography of the petroleum industry, containing some 12,000 items; the bibliography of the Petroleum Engineering Department of the Agricultural and Mechanical College of Texas; and a complete bibliography on the air-gas lift, supplied by S. F. Shaw. The references are arranged under about 900 different subjects.

The Engineering Foundation Annual Report 1944–1945; The Engineering Foundation, New York, 1945; 38 pages.

The annual report of The Engineering Foundation is presented in pamphlet form. It covers the fiscal period from October 1, 1944, to September 30, 1945. In addition to the annual financial statements, it reviews the activities of the Foundation in a general way and then gives detailed reports on current activities, including projects of the American Society of Civil Engineers, American Institute of Mining and Metallurgical Engineers, American Institute of Electrical Engineers, American Welding Society, Engineers' Council for Professional Development, and National Research Council. Lists of officers and members of the Board and of the committees of the Foundation, of the contributors to the Welding Research Council, and of the Foundation's publications are included.

Teach Yourself to Fly, by Squadron Leader Nigel Tangye; Published by David McKay Company, Philadelphia, 1946, for The English Universities Press, Ltd., London; 157 pages, $1.00.

The purpose of this book is to enable the prospect pilot to understand the fundamentals of the theory of piloting an aircraft before he has come in contact with the plane. Those with the ambition to become pilots should find the explanations, with supplementary diagrams, easy to grasp. The book is also intended to make possible a reduction in required instruction time. In addition to flying lessons, information is supplied about the controls and instruments of the plane.

The Significance of Tests of Petroleum Products; American Society for Testing Materials, Philadelphia, 1946; 76 pages, $1.00.

The fourth printing of a report issued to meet the need for information regarding the applicability of tests for petroleum products and lubricants now in common use in the United States and the significance of the results obtained. It was prepared by Committee D-2 on Petroleum Products and Lubricants of the A.S.T.M.

In the current edition the titles, designations, and publication references to standards and tentative standards have been brought up to date, except for two discontinued methods for which the original references have been retained.

Plastics Mold Engineering, by J. H. DuBois and W. I. Pribble; American Technical Society, Chicago, 1946; 494 pages, $7.00.

The fundamentals of plastics mold making and mold construction are set forth. The design of the important types of molds is described, and the uses for these molds are indicated. Because best results are obtained when molds are designed for toolroom equipment that is widely available, construction methods commonly employed are explained. Certain chapters deal with individual types of molds and specific molding processes. Procedures and calculations used in achieving the final mold design are included, and raw materials and product design considerations of interest to the mold designer are discussed.

A.S.T.M. Standards on Paint, Varnish, Lacquer, and Related Products; American Society for Testing Materials, Philadelphia, 1946; 528 pages, $2.75.

All of the A.S.T.M. specifications, methods of test, and definitions pertaining to paint, varnish, lacquer, and related products have been collected and placed in this volume for the convenience of the industry. The standard specifications, methods of test, and definitions are given in their existing form at the time of publication, but some of them are tentative and may be changed before adoption as standard.

1945 Supplement to A.S.T.M. Standards Including Tentatives, Part II; American Society for Testing Materials, Philadelphia, 1945; 229 pages, $4.00.

1945 Supplement to A.S.T.M. Standards Including Tentatives, Part III; American Society for Testing Materials, Philadelphia, 1945; 503 pages, $4.00.

Supplements to two books of A.S.T.M. standards are presented. One contains the newly adopted and revised A.S.T.M. tentative standards in the nonmetallic constructional materials field which have been accepted since the appearance of the *1944 Book of Standards, Part II*. Of the 24 standards, 14 are newly adopted and ten are replacements of existing standards. Thirteen of the 24 tentative standards are replacements, while the remaining eleven are published for the first time.

The second supplement contains the newly adopted and revised standards and the new and revised tentative standards in the nonmetallic general materials field which have been accepted since the appearance of the *1944 Book of Standards, Part III*. Of the 24 standards, eleven are newly adopted and 13 are replacements of existing standards. Twenty-seven of the 70 tentatives are replacements, while the remaining 43 are published for the first time.

Recommended Practices for Resistance Welding (Tentative); American Welding Society, New York, 1946; 47 pages, $0.50.

Prepared by the Resistance Welding Committee of the American Welding Society, this pamphlet contains data on tentative recommended practices. Sections are devoted to recommended practices for spot and seam welding, projection welding, flash-butt welding, and methods for testing resistance welds.

Your Post-War Place in Aviation, by Russ Brinkley; Aviation Press, New York, 1946; 96 pages, $0.50.

A civil aviation guide is offered for men who have served in the Armed Air Forces. It is also intended as an aid to student pilots, high-school students, and Civil Air Patrol Cadets. The various opportunities in civil aviation are described. The book includes information for pilots, mechanics, salesmen, those wishing to start an airport, and those who wish to enter the aviation-products manufacturing field. It also contains a large amount of other information and statistics in reference to civil aviation.

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Air Commando Doc, by Lt. Col. Robert Collier Page as told to Lt. Alfred Aiken; Bernard Ackerman, Inc., New York, 1945; 186 pages, $2.50.

A story of a carefully planned, daringly executed maneuver against the Japanese in Burma at a time when the lifeline to China was in grave jeopardy. It has to do with a secret project planned and carried out by the Army and the difficult task of organizing a medical unit to accompany the fighting fliers. The author tells how the flying doctors cared for the sick and wounded, fought tropical diseases and lack of sanitation, and met many other problems.

Report on the Air Power League's Progress, Fiscal Affairs and Projected Activities for 1946; Air Power League, New York, 1946; 18 pages.

A report on the Air Power League's progress, fiscal affairs, and projected activities for the year 1946 is presented in pamphlet form. The structure of the league is described, its policies and objectives are set forth, and educational and promotional activities are outlined. The charter members of the league and its present officers are listed.

Aviation, by H. E. Wimperis; Oxford University Press, New York, 1945; 184 pages, $1.25.

Designated as Volume 195 of the "Home University Library," this small book has been written to provide the reader with a general knowledge of various phases of aviation, including new developments in radio location and jet propulsion. Chapters are included on the growth of flying, research, flight and physiology, the airplane in war, civil aviation, and aviation in relation to world security. Data having reference to tests on models and the calculation of range are contained in appendixes.

Two-Way Radio, by Samuel Freedman; Ziff-Davis Publishing Company, New York, 1946; 506 pages, $5.00.

A new book describes the mechanics and applications of two-way radio for all forms of fixed, mobile, and portable communications. One chapter contains aeronautical applications of this equipment. The author discusses uses of aircraft radio and problems peculiar to it, design considerations, aircraft power supply, radio performance in aircraft, noise suppression, and direction finding.

Airport Survey and Recommendations, 1946; Future Springfield, Inc., Springfield, Mass., 1946; 15 pages.

Prepared for the City of Springfield, Mass., a report is made of a survey of the airport situation in that city and recommendations for improving conditions. The first part of the pamphlet deals with an airport for scheduled air-line operation; the second, with a second airport for nonscheduled flying.

Time Study and Motion Ecomomy, by Robert Lee Morrow; The Ronald Press Company, New York, 1946; 338 pages, $5.00.

A textbook on the fundamentals and advanced techniques of time study and motion economy. It is explained how motion economies, better methods, and the application of time studies result in the elimination of unnecessary manufacturing costs, better control of costs, and the overall success of a business. Ways to study operations, take observations, and completely compute the data to obtain sound standard times are discussed.

Wings Over America, by John Stuart; Public Affairs Committee, Inc., New York, 1946; 21 pages, $0.10.

Public Affairs Pamphlet No. 114 discusses the future of air power, with commercial and military aspects of the subject being examined. The author considers what is necessary to maintain military leadership in the air; whether or not the postwar production of military aircraft will be enough to maintain air power; the advantages of air transport; and the basis for personal aircraft growth. Charts are provided to clarify the text.

Petroleum Production, Volume 1, by Park J. Jones; Reinhold Publishing Corporation, New York, 1946; 228 pages, $4.50.

The first volume of a series of books about the methods of producing petroleum and its products is limited to that phase of the subject designated as the mechanics of production. The author states that the mechanics of producing oil may be considered in two steps: The first deals with that period in the history of a well prior to the time when water or gas breaks through into the well. The second phase takes place after these fluids make the break through.

It is the purpose of the first volume to advance for consideration a system of the mechanics for producing oil and condensate during the period prior to the breakthrough of displacement fluids into producing wells. An attempt is made to express physical facts in terms of the units and terminology used by the field personnel. Solutions of numerous examples have been included to enhance the value of the work.

Electronics Dictionary, by Lt. Comdr. Nelson M. Cooke and John Markus; McGraw-Hill Book Company, Inc., New York, 1945; 433 pages, $5.00.

A dictionary is offered for the student who is learning fundamental electronic principles. It contains over 6,000 terms used in radio, television, industrial electronics, communications, facsimile, and sound recording. Many illustrations are included.

Metal Working and Heat-Treatment Manual, by F. Johnson; Paul Elek (Publishers) Ltd., London, 1945; 204 pages, 17*s.* 6*d.*

Volume I of a series of four books on the heat-treatment of metals deals almost exclusively with the carbon steels. It has been written primarily for the engineer and student of engineering but is also intended to be useful to the metallurgist. The characteristics of the carbon steels and the processes used in conjunction with them are reviewed. The author discusses the influence of composition and treatment on the structure of carbon steels, hardenability, mechanical properties, and testing. The specifications of carbon and alloy steels are presented in an appendix.

Industrial Research and Patents; National Association of Manufacturers of the United States of America, New York, 1946; 36 pages.

Incorporated in this booklet are the addresses delivered at a symposium on patents and industrial research at the Golden Anniversary Congress of American Industry of the National Association of Manufacturers, New York, December 7, 1945. The addresses were delivered by Casper W. Ooms, Commissioner of Patents; Bruce K. Brown, Vice-President in Charge of Development, Standard Oil Company (Indiana); and E. R. Weidlein, Director of the Mellon Institute of Industrial Research.

Flying Hints for the A.T.C., by S. V. Leslie; Robertson & Mullens Ltd., Melbourne, Australia, 1944; 28 pages, 1*s.*

A pocket-sized guide is offered as an aid to members of the British Air Training Corps who propose to take up flying as their Air Force career. It contains hints for the assistance of both the pupil and instructor and follows the sequence of instruction given at an elementary flying school as closely as possible.

Geodetic and Photogrammetric Problems in Connection with the Mapping of a New Country, by Jose Fonseca and Leon Cuellar; Syracuse University, Syracuse, N.Y., 1945; 80 pages.

Discussion of a Photogrammetric Method for Constructing Topographic Maps from Aerial Photographs, by Earl Church; Syracuse University, Syracuse, N.Y., 1945; 16 pages.

Two of a series of bulletins on aerial photogrammetry published by Syracuse University. *Bulletin No. 10* contains important portions of a dissertation prepared by two engineers from the Republic of El Salvador who are receiving special training for the construction of a topographic map of that country. They deal with photogrammetric and geodetic problems.

Bulletin No. 16 discusses a proposed simple and cheap stereoscopic instrument for plotting topographic maps, in correct orthogonal projection to any desired scale, from rectified aerial photographs.

Fiction and Juvenile Books

Cherry Ames: Flight Nurse, by Helen Wells; Grosset & Dunlap, New York, 1945; 215 pages, $0.60.

On her return from nursing duties in the Pacific area, a young nurse volunteers for duty with the Air Forces and is trained for the highly specialized work.

She sees air action in Europe and becomes involved with an English family, solving the mystery of a "queer" son-in-law at the risk of her life and career.

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House Organs and Catalogues

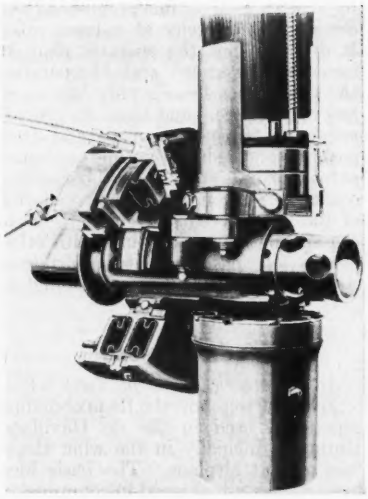
Engines and Propellers for Private Aircraft

Continental GR-9A and R-9A Radial Air-Cooled Aircraft Engines for Private Aircraft are described in a new catalog. Engineering improvements noted are a new fin design for cylinder head and barrel; new supercharger entrance, impeller, and discharge passages; pressure-type automatic carburetor; forced-feed lubrication to valve gear; new A.N. drives for hydraulic pump, vacuum pump, starter, generator, fuel pump and tachometer; and other refinements. The engines have higher power ratings than their predecessors, the R-9A being rated at 525 hp. and the GR-9A at 600 hp. for take-off, compared with the 450-hp. rating of the earlier models. The improvements are detailed in text and pictures, and power curves show the increased ratings.

Continental Aviation Skypower Propeller. A booklet of 12 pages illustrated in color gives details about the manufacturer's hydraulically operated, controllable-pitch propeller for personal airplanes. The stationary hydraulic actuator is mounted around the engine shaft and operates from the regular engine oil lines. The blade position is changed through a standard, ball-bearing transfer unit and set of links. The hydraulic system is closed, with no spinning hydraulic parts, no packing glands, gaskets, or seals. The blade bearings are independent of the blade mounting and can be changed without removing the blade from the ferrule. The basic pitch limits of the propeller can be adjusted to compensate for the varying altitudes of the airports from which the airplane may be operated. The booklet contains detailed descriptions of the features of the propeller. *Continental Motors Corporation.*

Aerial Cameras and Photogrammetric Instruments

Fairchild Aerial Camera Equipment. General descriptions and condensed specifications regarding Fairchild Camera & Instrument Corporation's principal aerial cameras and photogrammetric instruments are contained in this 16-page illustrated booklet. The described equipment includes the company's types T-5, K-17B, K-18, K-22, F-56, K-20, F-8, and Tri-metrogon aerial cameras; Type 05-A 35-mm. recording camera; Type B-3B intervalometer; vertical view finder; aerial roll-film developing apparatus; Type F-219 aerial roll-film drier; Type F-58 aerial roll-film contact printer; Type F-71 magnifying mirror stereoscope; Type F-163 parallax bar; and stereocomparagraph. *Fairchild Camera & Instrument Corporation.*



A cutaway view of the Continental Motors Corporation's hydraulically operated controllable-pitch propeller for light airplanes. The actuating unit and housing are stationary. The heart of the actuator comprises two flexible expanding rings, shown in cross section at left, connected with the engine oil system. The four-way valve controlled from the instrument panel makes possible the admission of oil under regular engine pressure to either ring, the second ring being automatically drained as the first expands. The resulting motion of the sliding collar between the expanding rings is communicated to the blades through linkage. Ball bearings are employed between the rotating and stationary parts.

Equipment for Measuring Surface Roughness

Profilometer Catalog—1946. A catalog on Profilometer equipment for measuring surface roughness offers suggestions pertinent to the quality control of surface finish and the designation of surface finishes on prints and specifications. Applications are indicated for the Profilometer and all accessories and attachments. Complete specifications and prices are given for each unit. Illustrations of the equipment are included. *Physicists Research Company,* Ann Arbor, Mich.

Dryseal Pipe Threads

What Dryseal Pipe Threads Are and How They Work. An 8-page booklet containing information about the recently set up standard for improvement in pipe threads is now available. In addition to explaining what Dryseal pipe threads are and how they work, it also recommends practices for using them. Charts and drawings supplement the text. *The Weatherhead Company,* Cleveland.

Template Production

Let's Talk about Templates. The process of reproducing aircraft templates by photo camera is shown in a series of twelve photographs. Accompanying notes impart information about the history and fundamentals of template making. *The Northrop News,* March 20, 1946.

Indicating and Recording Instruments

Precision Mercurial Gauges and Barometers. Bulletin D contains descriptions, specifications, and other data concerning a miscellaneous group of instruments including vacuum gages, absolute pressure gages, draft gages, manometers, barometers, altitude standards, gravitometers, ballistic instruments, and others.

Princo Thermoregulators, Thermostats, Relays. Bulletin T describes and illustrates a group of precision instruments for accurate temperature control, designed to meet the demands of industries and laboratories where precision temperature control is important. Thermoregulators are offered in five types and the thermostats in three types, each with supplementary thermometers, and the relays are of three different types. *Precision Thermometer & Instrument Company,* Philadelphia.

Rectifier Data

A Handbook of Dry Plate Rectifier Applications. G. A. Culbertson, Editor. Fundamental information concerning dry-plate rectifiers and their uses is compiled in a booklet of 16 pages. For the purpose of outlining general applications of the device, a rough classification divides the rectifier into two classes, designated as "power" and "circuit." The "power" classification is assumed to mean the use of the rectifier as an alternate for any other source of direct-current power, and "circuit" applications include all others. The first section of the handbook is devoted to the considerations involved in the selection of the circuit in specific power applications.

A chart is included showing the basic circuit arrangements in constant use and the fundamental characteristics of each. The text is supplemented by sketches showing circuit diagrams. *Culco Engineering*, Montrose, Calif. $0.50.

Maintenance Manual

Aeronca Champion Service Manual. A 43-page manual intended to aid owners, operators, and repair men in the work of protecting and maintaining the Aeronca Champion Model 7A. In addition to a general description of the airplane, with specifications and performance data, there are specific instructions dealing with the individual components of the airplane. Service drawings provide for positive identification of all parts according to the part numbers. *Aeronca Aircraft Corporation*, Middletown, Ohio. $2.50.

Small Pumps

Eastern Midget Pumps and Laboratory Stirrers. The various models of Eastern Midget Pumps are described briefly in a 20-page booklet. The information includes suggested applications for each type of pump, together with its construction, specifications, and performance. *Eastern Engineering Company*, New Haven, Conn.

Guide-Post Bushings

Ampco Metal Guide-Post Bushings. Bulletin No. 80 is a 4-page folder containing tabulated specifications for commercial guide-post bushings. The particular applications of these bushings and the construction details which give them the required properties are described. *Ampco Metal, Inc.*, Milwaukee.

Local Air-Line Service

What Is Different about Atlantic Airlines' Area Service and Why? In question-and-answer form a booklet of 20 pages outlines the operating principles by which a local air line proposes to render passenger service at reduced rates. It discloses how the operator plans to lessen the overhead cost of operating the ground service, simplify the handling of passengers and baggage, provide adequate transportation to and from airports, and reduce the time consumed at intermediate stops. The booklet also contains data concerning the population of the area served and comparisons of the air-line's time schedules with other means of passenger transportation. *Atlantic Airlines, Inc.*, Washington, D.C.

Technical Notes

Aero Research Technical Notes. Bulletin No. 39 tells how the Redux bonding process is used in the de Havilland Hornet, principally in the wing structure of that airplane. The basic idea involves the use of wood in compression and metal in tension, the top surface of the wing being made of wood and the bottom of light alloy. It is stated that the process enables the engineers to develop a composite wing structure of great strength in which the main tension stresses are carried on tapered T-section aluminum-alloy booms in the floor of the wing, and the main compression stresses are carried by two plywood skins, separated by close-spaced spanwise spruce stringers, forming the upper surface of the wing. Details are given about the construction of the wing spar, the wood and metal ribs, the means of local reinforcements, and metal-to-metal bonding in other parts. Modifications of the process as applied to the Sea Hornet are also described. *Bulletin No. 39, The Director of Research and Development, Aero Research, Limited*, Duxford, Cambridge, England.

Infrared Drying Units

Miskella Insulated Infra-Red Units. Superheat infrared units are supplied for use in the manufacturer's insulated ovens. They are manufactured in standard sizes and are interchangeable. Their construction, applications, and specifications are shown in a new data sheet. *Miskella Infra-Red Company*, Cleveland.

Engine Service Book

Lycoming Aviation Engines O-145 and GO-145 is an instruction handbook and parts catalog for the designated models of aircraft engines. Tabulated specifications and detailed descriptions are given of the two engines, together with comprehensive instructions for servicing and maintenance operations. The parts catalog is divided into three sections containing (1) exploded views with parts numbers indicated; (2) a numerical list of parts; and (3) an alphabetical list of parts. The concluding pages of the loose-leaf catalog contain service bulletins giving specific instructions for various maintenance operations. $2.50.

Lycoming Operator's Manual is a small ring-bound booklet containing operating instructions for the Lycoming Model 235-C aircraft engine. It contains tabulated specifications and text matter outlining the maintenance work required for various parts of the engine. *Lycoming Division, The Aviation Corporation*, Williamsport, Pa. $0.75.

Air-Line Analysis

An Analysis of the Airline Industry, a publication of a New York Stock Exchange member firm, contains a survey of the air-transport industry in general and specific information concerning Chicago and Southern Airlines, Inc. General background information about Chicago and Southern Airlines includes details about its routes, traffic statistics, air-mail contracts and earnings for the years 1940–1945, inclusive. Financial information about the company's capitalization and its financial position at the end of 1944 are listed. *Burnham & Company*, New York.

Right on the nose of the new CESSNA

THERE she stands, ready for the take off, the smart new Cessna 140 with shiny metal fuselage and new type landing gear. And right on the nose, giving more "pull" to every horsepower, is a Sensenich propeller. Very likely your post-war personal plane—no matter what its make—will be Sensenich-equipped. For among those who design aircraft as well as those who fly them, no other propeller is chosen so often by so many.

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Locking Devices

Waldes Truarc Retaining Rings. Catalog No. 4 is a revised edition of the manufacturer's catalog of retaining rings used in industry to lock, secure, or position moving parts, such as shafts, gears, bushings, or bearings. The distinctive features of each type of retaining ring are outlined and detailed descriptions and specifications of the devices with their numerous applications are given. Extensive tabulations list the dimensions and physical properties of internal and external retaining rings and of such special types as bowed, beveled, crescent, and inverted retaining rings, as well as self-locking rings and other types. A section of the booklet gives data concerning retaining rings for aircraft ball bearings, measured in inches and in metric figures. Other sections describe special tools used for installing and removing retaining rings. *Waldes Kohinoor, Inc.*, New York.

Coordinated Sea-Air Transport

The Sea-Air Combination in the National Interest. A booklet setting forth the steamship operators' point of view with respect to their ability to supply coordinated sea-and-air service. It summarizes arguments in favor of the operation of air lines by steamship organizations, emphasizing the world-wide facilities of the established ship lines and the reasons why, in the opinion of the steamship people, they are in a position to render efficient service through the combination of surface and air craft. *The Sea-Air Committee, National Federation of American Shipping, Inc.*, Washington, D.C.

Transport Forecast

The Outlook for the Air Transport Industry is a 4-page folder containing facts about the business position of the air-transport industry. It indicates the increase in the amount of travel by air and other factors bearing upon the industry's prospects. Attention is directed to the downward trend of air-line rates and the increased operating costs, and it is indicated that these problems are being overcome through the use of larger and faster airplanes. The benefits to be obtained from the use of improved equipment now becoming available are expected to be reflected in larger profits. *Delafield & Delafield*, (Members of the New York Stock Exchange), New York.

Aspects of Gliding and Soaring

Birds of a Feather is the title of a booklet published in the hope that it may help to give direction and impetus to gliding and soaring, not only as a sport for the individual, but for its value in research and experimental work, training of airmen, and in the transport field. In addition to a review of the progress made in these activities, the booklet gives suggestions about the steps to be taken to obtain the necessary instruction in gliding and the requirements that must be met in qualifying for a glider-pilot's license, either private or commercial. *Schweizer Aircraft Corporation*, Elmira, N.Y.

War Effort Review

Du Pont's Part in the National Security Program. The activities of E. I. du Pont de Nemours & Company during the wartime period of 1940–1945 are reviewed in a 64-page booklet. Contributions of the company are classified broadly under (1) production of war goods by the company from its own plants; (2) construction and operation of war plants for the U.S. Government; and (3) research projects undertaken by the company for Government agencies. Statistics are given in text, tables, and charts concerning the diversified operations of the company in these three principal classifications. *E. I. du Pont de Nemours & Company.*

Tachometers

Tachometer Bulletin No. 1045 lists a variety of portable and stationary tachometers, including centrifugal, chronometric, and vibrating-reed types, having single and multiple ranges. The various instruments are calibrated to indicate speeds ranging from 100 r.p.m. to 100,000 r.p.m. *Herman H. Sticht Company, Inc.*, New York.

Silicone Properties

Silastic Silicone Rubber. Bulletin No. 1 of a series makes available additional data concerning the manufacture and use of Dow Corning Silastic silicone rubber. The 4-page folder outlines the chemical structure of the material, its qualities of heat stability, electrical properties, low-temperature characteristics, chemical resistance, tensile strength and elongation, adhesion, and durability.

Silastic Facts is No. 2 of a series of leaflets referring to molding and extruding materials. It contains tables of physical properties, chemical characteristics, and other data concerning four classifications of Silastic stocks for molding, sheeting, calendering, or extruding. Technical information is given relative to the heat stability, abrasion resistance, and chemical resistance of the material, methods of fabricating and curing it, and procedures for molding, sheeting, and extruding it.

Dow Corning Mold Release Fluid and Compound. An 8-page folder outlines the properties and applications of Dow Corning mold-release fluid and compound which serve as lubricants to reduce friction between dies and plastics, improve plastic flow, and reduce surface striation. *Dow Corning Corporation*, Midland, Mich.

Metal Fabrication

Metal Fabricators is a 16-page booklet describing the facilities and services of a fabricator of metals. Photographs depict the various processes in welding, cutting, forming, and fabricating sheet metal. Other facilities include steel-plate construction work and the design and manufacture of special machinery and equipment. *Hungerford Corporation*, Big Flats, N.Y.

New Welding Method

Powder Weld is the title of a bulletin giving details of what is described as a new method of welding and brazing or surfacing with compositions of powdered materials. The equipment used consists of a torch similar to an ordinary welding torch but having a special patented nozzle and 16 independent controls, many of which are at the handle of the tool. The control box with pressure-regulating valves for air and gases, and a canister containing powdered materials, complete the equipment. The flame is generated and controlled by preselected combinations of gases and air. *Powder Weld Company*, Brooklyn.

Temperature Equipment

Cambridge Surface Pyrometers. Bulletin 194-SA contains data about portable surface pyrometers for use in plant and laboratory. It illustrates and describes the Cambridge roll pyrometer for determining the temperature of readily accessible rolls or other convex surfaces. Data are also given about an extension model for surfaces in inaccessible locations; a mold pyrometer for mold cavities or stationary surfaces; a needle model for measuring subsurface temperature of materials in a plastic or semiplastic state. Lists of typical applications accompany the description of each model. *Cambridge Instrument Company, Inc.*, New York.

Continuous Flow Measurement

Fischer & Porter Continuous Viscosimeters. Catalog Section 88A is a technical bulletin giving details about a new type of continuous viscosimeter. The instrument is constructed so as to permit instantaneous observation of viscosity values existing in a moving fluid stream under full line pressure. It is available as an indicating instrument or it can be arranged for recording viscosity values on a 24-hour chart, or for controlling fluid viscosity by automatic blending or heating means. The leaflet explains the principle of operation of the instrument and use of the equipment. *Fischer & Porter Company*, Hatboro, Pa.

Welding-Rod Chart

Hollup Selectrode Chart is printed in colors on index-tab-type sheets, intended for hanging on the wall of the shop. It is arranged to facilitate quick selection of the proper type and style of electrode for various welding operations as indicated by the index tabs, such as mild-steel electrodes, low-alloy steel electrodes, nonferrous and cast-iron electrodes, etc. It shows which electrode to use for a specific job, suggested applications, current values, positions, physical characteristics, and other data involved in welding work. *Hollup Corporation*, Chicago.

COOLING TURBINES

TO AIR CONDITION
JET FIGHTERS, BOMBERS, COMMERCIAL AIRCRAFT

Revolutionary New Development Makes Possible High Speed, Pressurized Flight

AiResearch Air Expansion Turbines make possible living room comfort in the pressurized cabins of the new Lockheed Constellation, the Douglas DC-6 and the Consolidated 240, three of America's fastest and most luxurious transport ships, soon to be in service. These turbines will be utilized in systems which cool the hot compressed air from the cabin supercharger before it reaches the pressurized cabin. The result is a comfortable, air-conditioned cabin at any altitude, at any speed and in any climatic condition.

AiResearch is the first to apply the principle of the expansion air turbine to aircraft airconditioning. It cools hot supercharged air by expanding it from high pressure down to cabin pressure and taking "work" out of it.

A complete line of air expansion turbines, both low and high pressure, weighing from 3 to 65 pounds and with temperature drops ranging from 45° to 135° have been developed.

Operating at speeds from 18,000 RPM to 100,000 RPM, the units incorporate a self contained lubrication system, and require air as the only source of power. The largest single turbine unit now in production will make available 12 tons of refrigeration for cooling cabin air.

AiResearch cooling turbines are being used in new planes of Douglas, Lockheed, Consolidated Vultee, North American, Republic and Northrop. The AiResearch background of engineering skill and research is available to help solve *your* AIRCRAFT airconditioning problems. AiResearch Manufacturing Company, Los Angeles 45, California.

TYPE	AIRFLOW PER MINUTE	TURBINE WEIGHT	TEMPERATURE DROP	R.P.M.	SUITABLE FOR
Simple	7 lbs.	3 lbs.	135°	100,000	Jet Fighters
Simple	10 lbs.	5 lbs.	135°	85,000	Jet Fighters
Simple	20 lbs.	10 lbs.	135°	48,000	Jet Medium Bombers
Simple	80 lbs.	34 lbs.	45°	18,000	Comm. Aircraft
Boot Strap	65 lbs.	25 lbs.	110°	32,000	Comm. Aircraft
Boot Strap	100 lbs.	65 lbs.	125°	27,000	Comm. Aircraft

AiResearch — manufacturers of AIR CONTROL equipment • Cabin Pressure Regulating Systems • Engine Oil Cooling Systems • Supercharger Aftercooling Systems • Temperature Control Systems • Engine Intercooling Systems • Automatic Exit Flap Control Systems.

AiResearch
DIVISION OF
THE GARRETT CORPORATION

Nickel-Alloy Steels

Bibliographies on Nickel Alloys. List "A" contains the titles and brief reviews of a group of books and periodical articles concerned with the production, fabrication, properties, and uses of nickel-alloy steels, nickel cast irons, nickel brasses and bronzes, and other nickel alloys.

List "B" refers to a similar group of booklets, technical bulletins, and periodical articles containing facts about the manufacturer's Monel metal, nickel, Inconel, and other special metals for industrial uses.

Properties and Uses of Some Cast Nickel Alloy Steels is one of a series of technical data books dealing with the properties and uses of those materials. It contains charts, tables, and text matter detailing the properties and applications of the alloys mentioned. *International Nickel Company, Inc.*, New York.

Air-Mail Prospects

The Outlook for Three-Cent Air Mail—A Postal View. Robert S. Burgess. The Superintendent of Domestic Air Mail Service of the U.S. Post Office Department sets forth his views about the operations of the air-mail service and the importance of air mail in the nation's economy. He reviews briefly the development of air-mail service in the United States, gives figures showing the growth of air-mail revenues, and explains the operation of the air-mail service from the time a letter is deposited in a street mailbox to its delivery. *The Pegasus*, April, 1946.

Wiring Material

AMP Solderless Wiring Devices. A loose-leaf binder contains the manufacturer's catalog sections giving data about devices for making electrical connections without solder. Catalog Section 10 outlines the features of insulation-support terminals showing the methods of using them and the tools supplied, as well as tabulated specifications. Catalog Section 20 gives similar details with regard to wiring terminals without insulation support, and Section 30 describes and illustrates installation tools for wire terminals. Section 40 is a guide for the selection of terminals, with tabulated specifications and dimensions.

Included in the binder is an illustrated catalog titled *AMP Simplified Wiring*, which brings together information about the design, construction, and applications of the manufacturer's simplified system of wiring. *Aircraft-Marine Products, Inc.*, Harrisburg, Pa.

Tools for Aircraft Work

Aircraft Tools is a ring-bound catalog giving information about tools for riveting, dimpling, drilling, cutting, bucking bars, and miscellaneous tools. In addition to descriptions, illustrations, and specifications of the various tools, the catalog contains general information about the manufacturer's facilities, and tables of technical data regarding the operations performed by the different tools described. *Aircraft Tools, Inc.*, Los Angeles.

Ducting Material

Air for Airplanes. Gerard S. Garey. A brief article tells about the application to airplane-maintenance work of the manufacturer's "Ventube" ducting which was developed originally for use in mines, to supply fresh air in the working spaces of the mine. The article relates how the tubing is made, how its design was adapted for use in providing ventilation in large airplanes, and how it is repaired in the event of damage or wear. Ducting has been found serviceable for supplying ventilation during work in wing and bilge compartments of large aircraft, and particularly when cleaning and repairing the fuel tanks. *Du Pont Magazine*, April–May, 1946.

List of Range Stations

Radio Range Stations of the United States is a booklet of twelve pages containing a compilation based on C.A.A. lists of the radio-range stations in the United States. The list is arranged alphabetically in order of the call letters of the station and also according to the names of the cities and towns in which the stations are located. The station index also gives the frequency on which each station operates. *Ranger Aircraft Radio Division of Electronics Specialty Company*, Los Angeles.

Airport-Equipment Booklet

Airport Electrical Equipment is a ring-bound, illustrated booklet of 56 pages containing typical lighting and wiring plans for all classes of airports. The equipment listed is designed to meet C.A.A. and Army and Navy standards. The descriptions and illustrations are keyed by symbols to wiring diagrams and lighting layouts appearing in the plant sections of the booklet, to assist engineers in meeting specific requirements for any type of airport operation.

Distribution equipment for which descriptions are given include fuse cutouts, relays, regulators, transformers, panel boards, and control panels. The section on lighting equipment deals with beacons, floodlights, boundary and obstruction lights, contact lights, ceiling projectors, wind indicators, and other units.

The third section of the booklet includes details about special equipment for small airports, alternate distribution apparatus, battery chargers, engine starters, and reserve power plants. *Westinghouse Electric Corporation.*

Friction-Tape Catalog Section

B. F. Goodrich Two-in-One Tape. Catalog Section 9270 refers to rubber tapes and splicing compounds. The manufacturer's Two-in-One tape is featured. This is designed to seal wire or cable splicing against the weather in a single operation requiring less than half the time needed by the combined use of friction tape and splicing compound. *The B. F. Goodrich Company.*

Stainless-Steel Control Equipment

CMH Stainless Steel Bellows. An illustrated booklet of twelve pages includes specifications, charts, cross-sectional drawings, and dimension tables of stainless-steel bellows used as equalizers, compensators, expansion joints, and flexible connectors, as well as flow-controls, thermostatic controls, electrical controls, and other applications. It is stated that the stainless-steel material from which these devices are made offers qualities of corrosion resistance, strength, temperature factors, and other important properties. *Booklet No. SSB-46, Chicago Metal Hose Corporation*, Maywood, Ill.

Enclosures for Private Airplanes

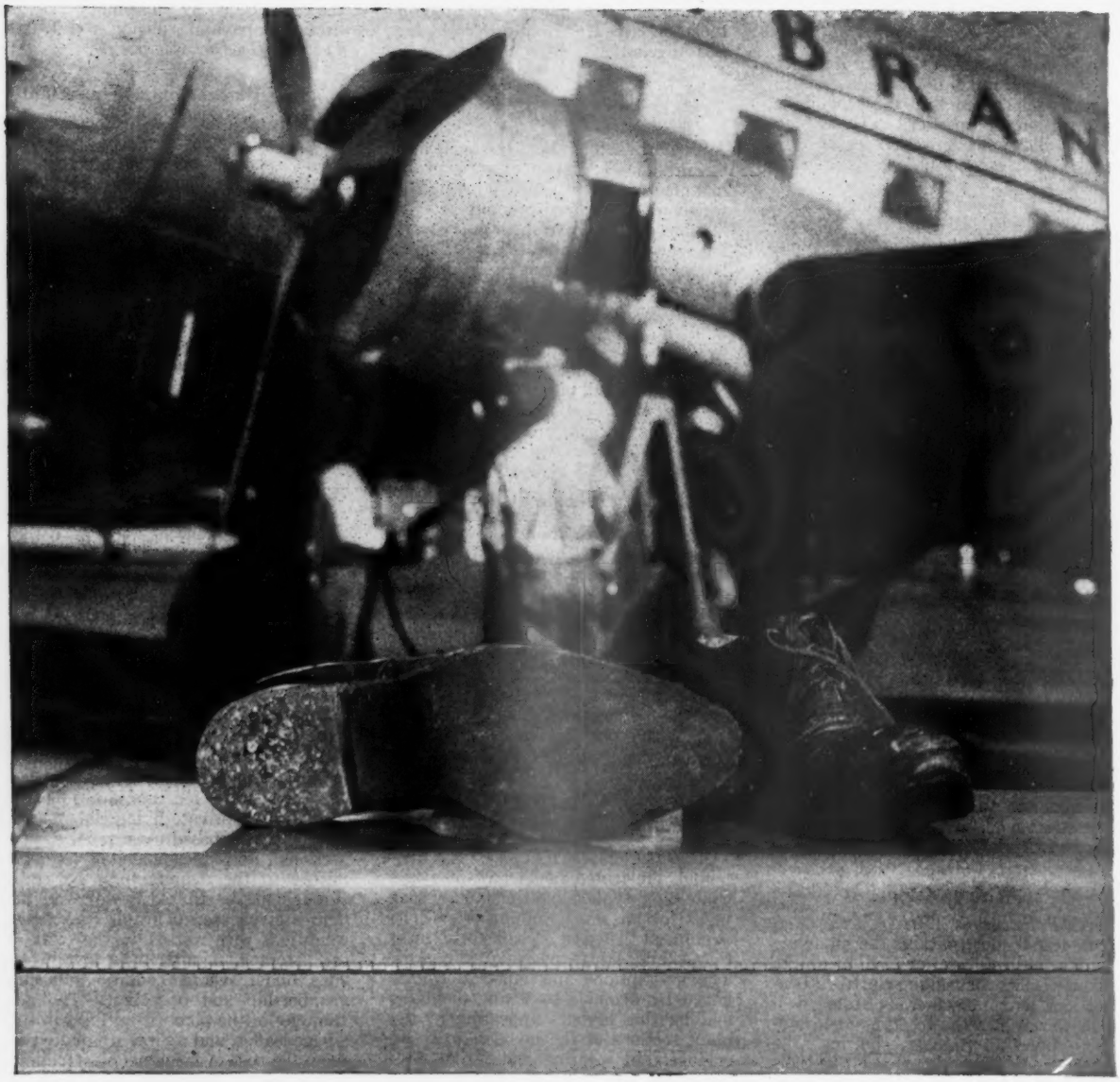
Aircraft Enclosures of Lucite. The adaptation to private airplanes of Lucite enclosures originally designed for fighter airplanes during the war is described. Cabin enclosures of this type are used on the Johnson Rocket 185, Piper Super Cruiser, the Globe Swift, All-American Aircraft Ensign, and the Commonwealth Skyranger. *Du Pont Plastics Bulletin, Volume 8*, 1946.

Formation of Private Flying Clubs

Aeronca's Proposal for the Formation of Light Plane Flying Clubs. Suggestions are made for procedures in the formation of private flying clubs. The information is based upon reports, suggestions, and recommendations submitted to the manufacturer by clubs throughout the United States, and the figures given are applicable to average conditions with respect to the costs of fuel, storage, maintenance, and insurance, under average conditions of club membership and operation. The advantages of the plan are outlined in the 8-page leaflet, and figures are quoted to show the cost of insurance, instruction, light-airplane operation and maintenance, and financing. The action to be taken in establishing a club is summarized and suggested forms are given for a code of regulations or by-laws for the club. *Aeronca Aircraft Corporation.*

Advances in the Use of Oil Additives

Lubricating Oil Additives. An article in which the characteristics and advantages of lubricating oil additives—first used for heavy-duty engine oils—are described, and the trend toward their use in oils for other types of equipment, including aircraft engines, is discussed. These additives are divided into two major classes, those useful for their properties as associated with the phenomenon of oil oxidation; and those added to improve some physical property of the oil. Both classes are treated. Particulars are supplied about the wear occurring in the pistons of engines lubricated with straight mineral oil and with oils containing additives. *Lubrication*, January, 1946.



The floor that walked before it flew

THE soft, comfortable feel of walking on plush carpeting is a luxury for the airline traveler, but it's a headache to the maintenance crew. Frequent cleaning, necessary to keep up a sanitary freshness, takes time, speeds wear. Rugs shrink, making it difficult to install them neatly.

To provide a cushioned flooring material, B. F. Goodrich developed a flight rug with a resilient sponge rubber base, and a new plastic covering made from limestone, coke and salt. The covering comes in rich colors, can be inlaid with attractive patterns.

Then, an enterprising foreman in Braniff Airways' upholstery shop decided to test the flooring by walking on it. He made the test tough on the flooring material, too. He had his shoes soled with the material, walked on them over the gravel runways, on the concrete floors of the shop.

The soles took the rough treatment, still looked good as new. And the test satisfied an exacting customer that the new B. F. Goodrich Flight Rug had the high abrasion-resistance needed for long, economical service. They also liked its beauty, the fact that it can be so easily cleaned with any good cleaner, the comfort of the cushioning, and the fact that it's fire-resistant.

B. F. Goodrich makes a complete line of airplane upholstery materials. For further information, write to The B. F. Goodrich Company, Aeronautical Division, Akron, Ohio.

B.F. Goodrich

FIRST IN RUBBER

From the Industry

Releases are printed as received from companies and other aeronautical organizations and the responsibility for the accuracy of all statements is therefore not assumed by the Aeronautical Engineering Review.

Air-Transport Records in War Service

The movement of 18,624,596 lbs. of medical supplies and surgical equipment by air transport to overseas areas was disclosed in a summary of statistics issued by the Air Transport Association of America.

The bulk of the critical articles, transported between 1942 and June 30, 1945, were flown by the Army Air Forces which handled 17,337,540 lbs., while Navy airmen flew 1,287,056 lbs. In addition, thousands of pints of whole blood were flown from donor stations in the United States to the European and Pacific war zones and nearby hospitals. The commercial air lines of the United States shared in the service both on their domestic routes and under military contracts overseas.

Data compiled from records of the Army, Navy, Marine Corps, Red Cross, and similar organizations, include the following facts: About 1,033,481 wounded and ill military patients of the American and Allied forces were evacuated by the Army Air Transport Command. That total covers the period from the fall of 1942, when extensive air evacuation was initiated in the South Pacific during the counteroffensives on Guadalcanal and New Guinea, to April 30, 1945. A total of 386,000 pints of whole blood were flown overseas for treatment of American fighting men. Of this, 206,000 pints went to European fronts and 180,000 to the Pacific area. An idea of the movement of supplies by the Army overseas is given in the report that nearly 3,000 tons, or 6,000,000 lbs., of medical supplies were moved from England to the Continent by air from August 1 to December 25, 1944. Much of the tonnage consisted of whole blood, penicillin, medicines, and surgical materials. The amount of airborne whole-blood shipments handled by the Navy depots for the period of December, 1944, through May, 1945, when the fighting was severest in the Pacific theater, totaled 131,000 units, measuring 427,000 cu.ft. and weighing 510,000 lbs. Daily shipments by the Naval Air Transport Service alone ranged from 300 to 1,800 pints, depending upon battle conditions.

Nearly 100 per cent of the more than 300,000 casualties evacuated from east of the Rhine in the final phases of the European war were transported by aircraft. In this theater air-evacuation units, totaling as many as 100 planes a day, assisted ground armies in moving their hospitals forward by means of air transport. One out of every four wounded servicemen evacuated from the European continent was flown either to England or the United States. One out of every ten was flown direct to America. Air Transport Association.

Engine for Four-Place Family Planes

The Franklin "335," a horizontally opposed air-cooled engine of advanced design, has been chosen to power two of the new planes in the four-place "family" class. The planes are the low-wing Bellanca Cruisair and the high-wing Stinson Voyager 150.

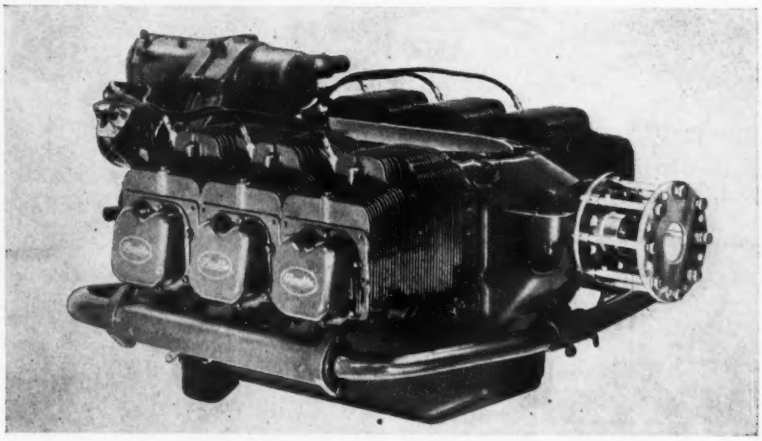
The new engine is an adaptation of a successful Army model. Designation of the engine as the "335" denotes its 335 cu.in. displacement, which produces 150 hp. at 2,600 r.p.m. It is of the 6-cylinder, horizontally opposed type, and has several unusual new features. Among these is a newly designed one-piece aluminum cylinder with greatly increased cooling surface of more than 7,500 sq.in., or almost 23 sq.in. per cu. in. of displacement. It is said that this results in pistons running cooler, lower oil temperature, and longer lasting valves.

A special float-type carburetor has also been designed especially for the engine, with several features believed by the builder to be new to the personal-plane field, being customarily found only on much larger engines. These include a built-in altitude control adjustable by the pilot from the instrument panel, an accelerator pump for quicker starting, and a carburetor idle cutoff to insure positive stopping of the engine. Other new features include a heavy-duty crankshaft, carburized alloy-steel timing gears, and external oil-pressure relief valve. Aircooled Motors, Inc.

Commercial Helicopter Licensed

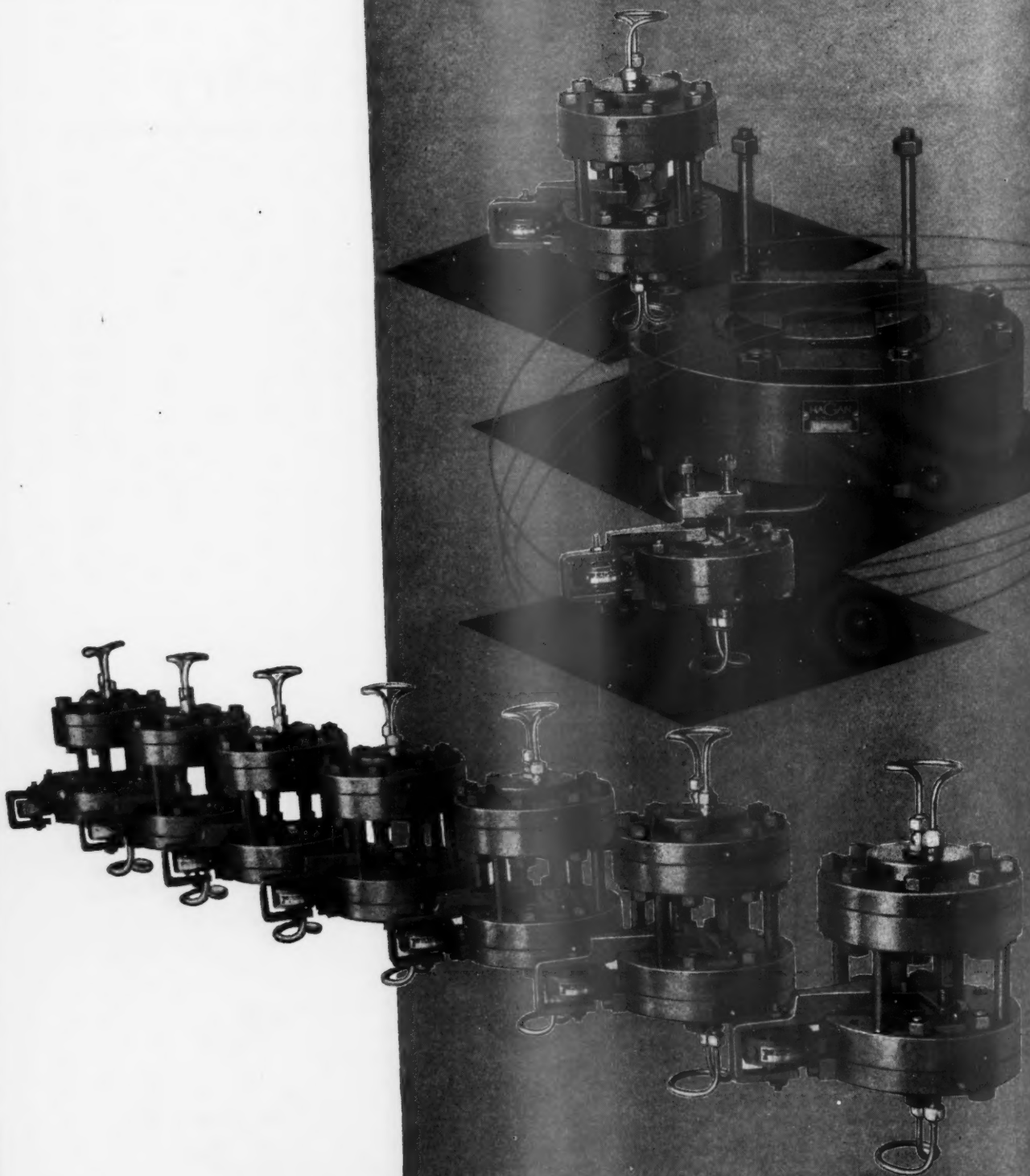
The Bell two-place Model 47 helicopter will be the first to be released by the company to the civilian market. An initial quantity of 500 of these machines is now in production and the manufacturer states that production will be expedited as rapidly as possible. Announcement of the delivery schedule follows Bell Aircraft Corporation's receipt on March 8 of what is said to be the first commercial helicopter license granted by the C.A.A.

Equipped with a 175-hp., six-cylinder, Franklin air-cooled engine, the Bell Model 47 utilizes a patented two-bladed rotor and gyroscopic stabilizer system. The gross weight is 2,100 lbs. including a useful load of 607 lbs. The main rotor diameter is 33 ft. 6 in. Its overall length is 39.5 ft.; cabin internal length, 3.9 ft.; cabin internal width, 4.3 ft.; and cabin internal height, 4.1 ft. It has a two-door enclosed cabin, four-wheel landing



The 150-hp. horizontally opposed Franklin "335" engine.

THRUSTORQS



HAGAN CORPORATION, HAGAN BUILDING, PITTSBURGH 30

HAGAN
HALL
BUROMIN
CALGON

are now ready for

Quick Shipment

When any device as versatile as Hagan THRUSTORQ is made available to industry, there is necessarily a period of experiment during which users determine the applications which are of most value to them. At the end of this period, the manufacturer has a better idea of the types and sizes for which there is greatest demand; it is no longer necessary to make each unit a special order, and "stock-piling" of popular sizes can begin.

Hagan is pleased to announce that this stage has been reached in THRUSTORQ production.

This unique system for measuring thrust and torque *with air* has been applied to single test cylinders, to complete automobile and airplane engines, to helicopter engines, to jet propulsion, even to "buzz bombs." As a result of experience with these applications, Hagan has been able to set up a standard line of THRUSTORQS, and these are available for shipment, in quantities adequate for production testing.

Because of the accuracy, flexibility, convenience and range of Hagan THRUSTORQ, new applications are steadily appearing not only in the aviation and automotive industries but also in many other fields.

Hagan Bulletin 9345 which describes the principle and operation of THRUSTORQ may suggest applications which will be of value to you. We will be glad to send you a copy. There's no obligation—just mail the coupon below.

AVAILABLE DESIGNS

The Hagan THRUSTORQ is available in single and double units in the following sizes:

THRUSTORQ No.	Maximum Force When Generating 100 psi. Measurement Pressure
3.5	350 lbs.
5.5	550 lbs.
12.0	1,200 lbs.
30.0	3,000 lbs.
60.0	6,000 lbs.
116.0	11,600 lbs.

The THRUSTORQ number also designates the nominal diaphragm area in square inches.

HAGAN THRUSTORQ
measuring thrust and torque *with air!*

HAGAN CORPORATION
HAGAN BUILDING
PITTSBURGH 30, PA.

Please send me your Bulletin 9345 "The Hagan THRUSTORQ and Its Application to Engine Testing."

NAME

POSITION

COMPANY

STREET AND NUMBER

POST OFFICE ZONE NO. STATE

Bell Aircraft Corporation's new production Model 47 two-place helicopter in flight at the corporation's main factory near Niagara Falls. The force of the wind is illustrated by the American flag at top left.

gear, dual control, all necessary instruments, and radio. In extensive flight tests by C.A.A. representatives, speeds in excess of 100 m.p.h. were attained. Operating speed is 80 m.p.h. and range is approximately 250 miles. Bell Aircraft Corporation.

Plastic Slide Rule

A new 10-in. slide rule is made of a plastic material that is stated to have remarkable dimensional stability. The graduations are not affected by temperature change. The glass indicator is mounted in a polished stainless-steel frame that holds it firmly in place.

The graduations are precise and will not lose visibility through use. The *CI* scale shows numerals and graduations in red to provide ease of reading. To permit the widest possible range of service, *A*, *B*, *CI*, *C*, *D*, *K*, *S*, *L*, and *T* scales are shown. The beveled edges of the rule are graduated in inches and centimeters. Because of its all-plastic construction, binding or sticking of the slide under varying atmospheric conditions is said to be eliminated. The tension on the slide is easily adjusted by four screws on the back of the rule. The indicator glass may be readily replaced in the event of breakage. Charles Bruning Company, Inc., Chicago.

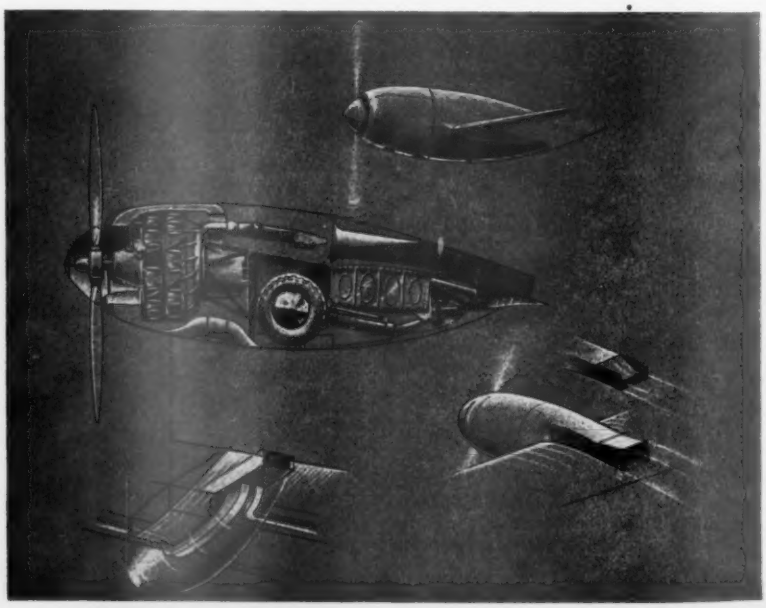
Convair-240 Power-Plant Installation

The power plant on the Convair-240 air liner has been designed to take advantage of the benefits from exhaust-aspirated cooling. These advantages are reported to be (1) improved cooling accompanied by forced evacuation of the cooling air aft of the engine; (2) an increase in forward speed resulting from elimination of cowl flaps, and thrust provided by high-velocity exhaust and air from the rear of the nacelle; (3) the ability to obtain large quantities of heated air for heat anti-icing and cabin heat without using the conventional heat exchanger.

Cooling of the power plant is accomplished by enclosing the engine in an airtight cowl having the usual opening at the front but having no cowl openings except an augmenter exit at the rear. The engine exhaust is led aft through the collector and tail pipe and is forced into the augmenter stack as a jet through the use of special nozzles. This jet action forces the air into the augmenter together with the exhaust gas, creating a low pressure in back of the engine into which cooling air will flow. This action is continuous at all times when the engine is running. The aspirating action of the exhaust increases as the amount of exhaust gas increases, so engine cooling is automatically proportional to the engine output. It is unnecessary, therefore, to provide cowl flaps which are opened during flight, particularly in climb.

The use of the exhaust ejector for cooling also results in an increase in thrust from recovery of the energy normally wasted. In the case of the Convair-240 this is estimated to give a speed increase varying from 10 m.p.h. at cruising speed to 12 m.p.h. at normal rate of power. This thrust is gained because the cooling air is accelerated in passing through the augmenter and is moving aft at a speed of approximately 360 m.p.h. during cruising conditions. The combined mass of cooling air and exhaust gas is considerable, and a thrust of approximately 375 lbs. is obtained for the two engines. This increase is said to amount to 255 thrust hp. at cruising speed.

Because the exhaust gas and engine cooling air are combined in the augmenter, a temperature of approximately 360°F. can be obtained for the gas toward the rear of the augmenter. Since this temperature is adequate for heat anti-icing and cabin heating it is only necessary to add flush take-off scoops in the bottom of the augmenter to obtain adequate quantities of heat for all purposes. These scoops take in a mixture of exhaust and air, so that it is necessary to have a secondary heat exchanger for cabin heating. The weight of this secondary heat exchanger is



The benefits of exhaust-aspirated cooling are taken advantage of in the installation of the power plant on the Convair-240 air liner. The aspirated-exhaust feature eliminates complicated cowl mechanisms and makes a smooth nacelle possible. Even at idling speeds sufficient air is drawn over the engine for cooling purposes. The jet effect adds 375 lbs. of thrust or approximately 255 hp. at cruising speed.

considerably less than the weight of a heat exchanger capable of supplying both wing heat and cabin heat. Consolidated Vultee Aircraft Corporation.

Engine-Replacement Service for Private Planes

Continental Motors Corporation is perfecting final details of a broad five-point program designed to improve engine-service facilities for light-plane owners throughout the country. This program involves (1) virtually doubling the number of Continental airplane-engine distributors and dealers, and (2) backing this augmented field organization with factory skill and equipment for handling major overhaul jobs.

Although the plan contemplates that the factory will henceforth handle a great many overhaul jobs heretofore done in the field, costs of such factory remanufacturing have been established on a basis that will afford distributors and dealers a normal profit margin and still give plane owners a better arrangement on cost than they have had in the past. From the owners' standpoint, factory remanufactured engines will have the additional important advantages of carrying a new-engine guarantee.

Many distributors and dealers in localities where airplane population is sparse will benefit from the program through not having to maintain extensive service facilities. Those located in major centers, however, and equipped to do such work, will continue to handle such major overhaul jobs as they may desire, although they or the plane owners in their territory may avail themselves of the factory's remanufacturing plan at will.

The five-point engine-service program to be carried out through this distributor-dealer organization is as follows:

(1) All distributors are to stock factory remanufactured engines for exchange at fixed prices for used engines. The remanufactured engines will carry a new-engine guarantee. Four engine models, the A-65, A-75, C-75, and C-85 are included in the exchange plan at the outset. Prices f.o.b. Muskegon range from about $247 to $288, for engines without carburetor, magneto, generator, starter, voltage regulator, wiring harness, spark plugs, propeller hub, oil sump, and carburetor air-heater valve. Engines, less these accessories, accepted for exchange must be in "runnable" condition and the factory reserves the right to reject any engine submitted for exchange.

(2) A plane owner who wishes to keep his own engine may have it individually remanufactured at the factory for a flat price of $110 for labor plus the cost of any new parts needed. Such engines also will carry a new-engine guarantee. They may be shipped to the factory by distributors and dealers or the plane may be flown to Muskegon and the engine taken out there for remanufacturing.

(3) An exchange plan similar to that on engines is being worked out for accessories such as carburetors, magnetos, generators, fuel pumps, etc. Remanufactured accessories carrying a "new" guarantee from the respective manufacturers will be stocked by Continental distributors.

(4) All distributors and dealers will be required to carry a stock of replacement parts adequate to handle field service needs in their respective localities. The intent of this requirement is to enable a plane owner to get an immediate replacement for a broken or worn part, rather than to have to wait until the part can be ordered from the factory.

(5) Flat rates for various types of engine-repair work are being "suggested" to distributors and dealers alike. While it is not mandatory that these rates be followed, it is believed that they will be of material assistance in stabilizing service charges at fairly standard levels throughout the country. Continental Motors Corporation.

Small Heat-Treating Furnaces

Two new optional features have been added to Cooley muffle-type electric furnaces. The standard furnace is manufactured with a hinged door which, when opened, forms a loading shelf. It is now offered in an alternate design incorporating a counterweighted, vertically operated door for use where only partial door opening to the furnace is required.

The furnaces are manufactured in two standard sizes, the MH-3 with chamber dimensions of 8 in. wide by 6 in. high by 14 in. long, and the MH-4 with dimensions of 10 in. wide by 6 in. high by 18 in. long, for continuous operation at 1,750°F., or intermittent operation at 1,850°F. Heating time to 1,400°F. is approximately 40 min., while heating to 1,850°F. can be accomplished in 55 to 65 min. These furnaces are usually operated with an indicating controlling pyrometer. With this equipment, procedures may be accurately followed.

These furnaces may also be used for other operations, such as drawing, tempering, normalizing, annealing, preheating for high-speed hardening, emergency repairs, and experimental testing for established heat-treating procedures. In addition, they have been used in production lines where it is necessary to heat small parts to facilitate assembly.

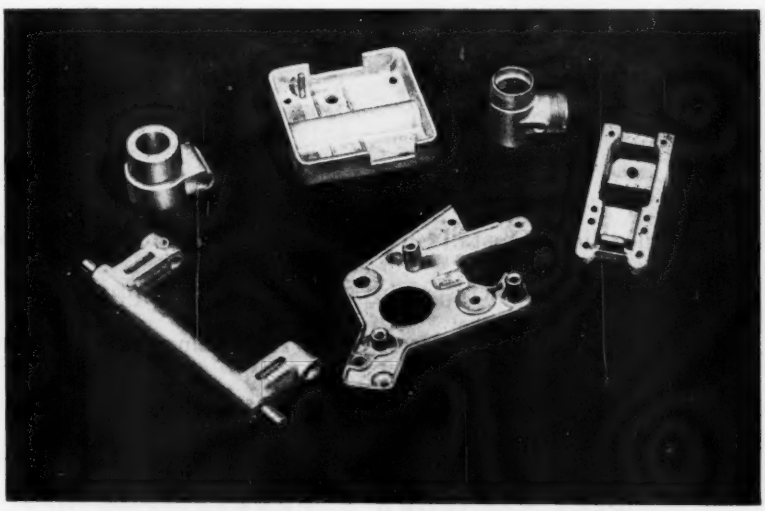
The second new feature now being offered is a heavy-gage structural steel stand of welded construction. It serves as a bench for the furnace, providing a shelf for storage space beneath the table-top area. The stand has established the furnace at the proper working height, with the furnace hearth 42 in. above the floor.

Cooley muffle-type electric furnaces are simply constructed. The outer shell is of heavy-gage sheet steel, well insulated, and with cast-iron end frames, typical of heavy production-furnace design. Elements are of the embedded type which afford protection to the element wire from atmospheric attack. Interlocking, rectangular elements form the interior of the chamber, and heating element replacement is a simple matter. The heating-element arrangement, coupled with the design of the furnace, holds the chamber temperature to an even level, so that there are no cold spots. These furnaces may be obtained with either the new vertically operating door or the bottom-hinged door. Cooley Electric Manufacturing Corporation, Indianapolis.

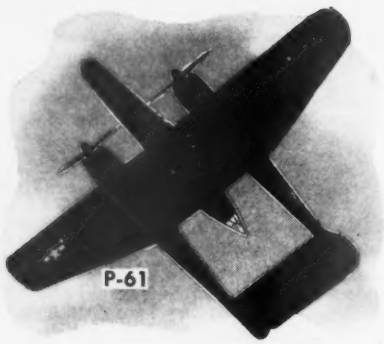
Low-Cost Die-Casting Machine

On-the-spot die casting is made available for industry through the development of a high-speed production die-casting machine. Machine-tool dealers supply completely prefabricated blank die sets, permitting the manufacturer to make his own dies. All that is required is machining the die cavity and grinding the gate.

The DCMT machine takes only 2 to 3 min. to set up. High production or low runs of die castings can be produced



Using prefabricated blank die sets, die castings can be produced economically on the DCMT die caster in runs as low as 350 parts.

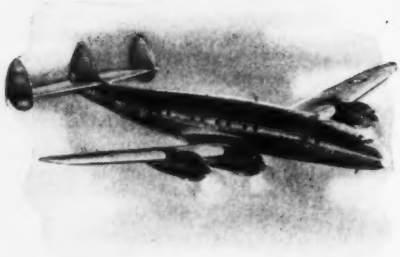


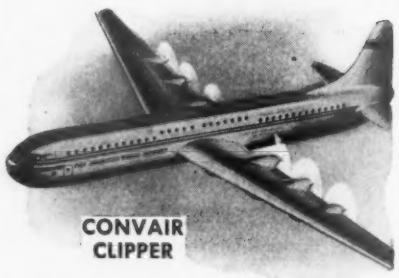
WINNERS

C-69

Some of these airplanes helped win the war . . . others are keeping the peace, and giving world travelers faster, more economical air transportation. Many more such planes are on the drawing-boards, for America's future air progress. Improved efficiency of operation is accomplished by the use of Chandler-Evans products on these planes.

PB4Y-2





Mere chance did not install Chandler-Evans equipment on all these headliners. And Chandler-Evans' research, engineering and production will continue in order to provide carburetors and fuel pumps for tomorrow's winners.

CARBURETORS FUEL PUMPS PROTEK-PLUGS

CHANDLER-EVANS CORPORATION

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in the shop as required, eliminating the need for large inventories. Runs as small as 250 parts are now made economical, while production speeds of 600 shots per hour may be reached. The DCMT Die Caster is light and simple in operation, and may be run by unskilled personnel. DCMT Sales Corporation, New York.

High-Speed Metal Saw

The DoAll Zephyr 16 high-speed metal-cutting band saw is designed primarily for light-gage steel and foundry application, and is also applicable to woodworking and pattern shops, as well as on production lines where it is desired to cut material as fast as it can be fed into the saw.

This smaller version of the DoAll Company's Zephyr 36 has a 16-in. throat depth and a 10-in. thickness capacity. Featuring the manufacturer's patented speed assembly, the machine has an infinitely variable speed range from 1,000 to 5,000 ft. per min.

The combination of controlled saw speed and the special saw blade make extremely fast cutting rates possible in sheet steel, aluminum, and ferrous and nonferrous castings, as well as paper, wood, plastics, laminates, and composition materials. Steel springs and links, flexible steel tubing, laminated rubber and steel, or aluminum and wood, combinations of steel and copper, steel and rubber tubing, or porcelain-coated steel can all be sawed on the machine with speed and good finish.

The table of the saw is of the tilting type and there are a disc cutting attachment for making circles, a rip fence, and a mitering attachment for cutting of regular and compound angles. Hardened steel saw guides with roller back-up bearings hold the blade firm for straight, true cuts to close tolerance. The DoAll Company, Minneapolis.

Douglas Rocket Ascends 230,000 Ft.

What is stated to be the first American-made rocket actually to leave the earth's atmosphere and penetrate the ionosphere 46 miles "straight up" has been constructed by the Douglas Aircraft Company. Tested by the U.S. Army, the new rocket ascended to 230,000 ft.

The rocket has been under development at California Institute of Technology for the Army Ordnance department. While restrictions of military secrecy were only partially lifted, the Army has permitted the company to reveal that the rocket is 16 ft. long and 12 in. in diameter, and is made of steel, aluminum, and magnesium. It has been named the "WAC Corporal."

Power comes from a liquid propellant that combines the fuel and oxidizer, and the rocket has three tail fins that stabilize it in flight. Although it is known to carry scientific instruments, no indication was given by the Army as to the loads carried by the rocket.

Scientists working on the project explained that the rocket is not a war weapon but a research instrument for the Army and Navy. It may be used by other Government agencies, including the U.S. Weather Bureau, to explore the upper atmosphere and the ionosphere, and by the N.A.C.A. to seek data on wind velocities, temperatures, gravity, and aerodynamic drag. Douglas Aircraft Company, Inc.

Small "Grindstones" Made of Neoprene

Neoprene is now being formulated with abrasive particles into small resilient pellets that act as grindstones to smooth the rough edges of metal stampings, castings, and precision-machined parts. The pellets are used in tumbling barrels for deburring parts made of brass, steel, or the light metals. The pellets are composed of aluminum oxide bonded with neoprene and may be used in virtually any tumbling barrel. Users have recommended a special barrel lined with neoprene. The lining resists abrasion and prevents damage to delicate parts in the tumbling operation.

The synthetic rubber composition in the pellets serves both as a cushioning agent and a matrix for the abrasive. The cushioning effect separates parts being finished, important when deburring items having easily damaged threads, serrations, or soft-metal parts. Neoprene also supplies a flexible backing for each particle of aluminum oxide, it is reported, insuring a constant, even honing pressure as the abrasive removes burrs and sharp edges. The soft neoprene binder permits penetration into threads and serrations, bringing the abrasive in contact with all surfaces. Examination of an actual operation shows that some of the pellets wear to small pieces which reach into deep recesses and small areas and remain useful until completely worn down. E. I. du Pont de Nemours & Company, Inc.

Plastic to Resist Heat and Chemicals

A new industrial plastic that withstands acids and retains its strength and form at higher temperatures than other known organic materials is contributing importantly to modern engineering developments such as the jet engine. Radar and television are among other fields in which it is solving serious problems. It is stated that no substance has been found which will dissolve or even swell the polymer.

The plastic material—tetrafluoroethylene resin—to be known by the trade-mark "Teflon," was developed in du Pont research laboratories. It was manufactured for special military uses during the war in a pilot plant at the Arlington, N.J., plant of the company's Plastics Department. Limited amounts in the form of sheets, rods, tubes, coated wire, tape, and fabricated sections are now available for experimental purposes. Difficulty in fabrication and high cost of manufacture are limiting factors in the plastic's present stage of development.

It is predicted that the new plastic will find use by industry where unusual resistance to solvents and corrosive agents is demanded, where heat endurance is of paramount importance, and where insulation against high electrical frequencies is needed in combination with one or both of these properties.

Gaskets and wire insulation for jet engines are now made of this plastic, which is unharmed by temperatures ranging up to 575°F. It is also used in aircraft ignition systems near spark plugs where ordinary insulators are affected by high temperatures. Conduits subject to attack by corrosive materials, and spacers for coaxial cables conducting high-frequency circuits for radio, radar, and television are other current applications.

With regard to the material's chemical resistance, it is said that such reagents as aqua regia, chlorosulphonic acid, acetyl chloride, boron trifluoride, hot sulphuric acid, hot nitric acid, and boiling solutions of sodium hydroxide do not affect the polymer. Subjected to a temperature of 572°F. continuously for 3 months in a recent test, it showed virtually no degradation. The plastic retained all of its useful properties at that temperature. Conversely, it is not adversely affected by temperatures as low as −75°F.

Because its dielectric loss factor is low, even at frequencies up to 3,000 megacycles, it is suitable as insulating material for currents of ultra-high frequency. A water-absorption rate so low as to be rated "zero," high impact strength, and toughness are among its other properties. E. I. du Pont de Nemours & Company, Inc.

New Resin Structural Panels

Structural panels made from a new resin, reinforced with glass fabric or other materials, are undergoing tests for airplanes, automobiles, and other applications. The resin—known as BCM—is reported to have excellent bonding properties and high resistance to heat.

The liquid resin is used chiefly with glass fabric laminates at present, although it may also be applied to paper, hemp, wood, and various cloths. It requires only a short curing period and low laminating pressure, and can be used as an impregnating and laminating resin either by itself or mixed with a polymer. In the cured state, BCM has no odor and is resistant to most organic materials. Absorption of water and other common solvents, such as acetone and ethanol, is low, from 1 to 2 per cent.

The new resin is thermosetting. When cast as a transparent sheet on table tops, it has a permanent high-gloss finish. In addition, thin veneers to which BCM has been applied can be bent without crazing or peeling the resin.

Experiments have shown that a wide range of colors can be obtained by adding oil-soluble dyes or pigments to the resin. Cast BCM may be worked with high-speed tools easily by the same methods as used for methacrylates like Lucite acrylic resin. E. I. du Pont de Nemours & Company, Inc.

Lightweight Plastic Developed by Du Pont

A foamed plastic of cellular cellulose acetate, designated as "CCA," is envisioned for use as the strong, lightweight cores in airplane floor panels, tail assemblies and wing structures, and for other industrial uses. Lighter than cork, this new plastic combines insulation against heat and cold with structural strength when bonded between two sheets of metal, wood, or plastic.

The material was suggested by a chance observation in a du Pont plastics plant. A cold slug of cellulose acetate, clogging a molding machine, was heated so that it could be dislodged by the pressure of the ram. An unoriented, multicellular form of the plastic issued from the machine.

The plastic has adequate compressive strength. When bonded between two panels of metal, wood, or another plastic, it will not be compressed or squeezed except under extreme pressure. Furthermore, the thin sheets of metal, wood, or plastic, which would themselves ordinarily bend under load, are effectively supported by the strong core of plastic. The thermal-insulating properties are virtually the same as those of cork, balsa wood, and other rigid insulating materials, and the heat resistance is such that thermosetting resins can be used to cement it for use in laminations for panels.

The material is uniform in density. It is not brittle, nor will it crack or break down under vibration. It is now made in strips $3\frac{1}{2}$ in. wide, $\frac{5}{8}$ in. thick, and of any desired length. The strips may be readily glued together with thermosetting adhesives to form thick sections. Likewise, the plastic may be bonded with ease to metal, wood, or another plastic. Aluminum, magnesium, steel, and stainless steel are among the metals that may be bonded to cellular cellulose acetate. The plastic may be tooled or shaped by any woodworking machinery. It will be made in four ranges of density—four to five pounds per cu.ft., six to seven pounds, seven to eight pounds, and eight to nine pounds per cu.ft. E. I. du Pont de Nemours & Company, Inc.

Edison Sensitive Magnetic Relay

Designed and built to meet the exacting requirements of the aircraft industry, the new Edison Sensitive Magnetic Relay Model 103 is now available for use in the electronic and industrial fields where relays are required for operation on currents of thermocouple and photocell magnitudes and in equipment where compactness, light weight, and dependability under vibration are of primary importance. It is particularly useful as a polarized relay in vacuum-tube circuits, in balanced circuits, and in applications requiring "pull in" and "drop out" at essentially the same current or voltage. In extremely delicate control circuits, this relay can be used to help "shrink" mechanical design by eliminating intermediate amplification. The entire mechanism is protected against weather and dust by a gasketed metal cover and it is balanced to allow operation in any position.

Ex-Cell-O Corporation's improved drill-chip breaker.

The essential design of the relay is an inversion of the d'Arsonval galvanometer-type movement in that the permanent magnet swings and the coils are stationary. This feature makes it practical to use bobbin-wound coils containing more wire than usual and thus gives considerable latitude in the selection of resistance values to match associated circuits. Two coils are used which may be connected either in series or differentially so that the relay will operate on the difference between the currents in the two coils.

The contacts will handle $\frac{1}{3}$ amp. in a noninductive load circuit; and provide either single-throw or double-throw switching. Operating power is normally about 10 microwatts although for some circuit applications operation may be secured with less than 1 microwatt. The coils will safely dissipate 2 watts, allowing differential operation on large currents, while the construction will withstand substantial overloads without damage when used as a simple relay.

The magnetic system of the relay is enclosed in a permeable metal shield that protects it from stray external magnetic fields. The rotor is pivoted in spring-loaded jewel bearings and has a small Alnico vane at its lower end. At its upper end it has a hairspring, a balance cross with weights and a platinum-iridium contact arm. The magnet vane is positioned between two parallel stationary coils whose magnetic fields are coincident. The aluminum cover is mounted on a standard small seven-pin radio tube base. The diameter of the unit is $1\frac{1}{4}$ in.; its seated height is $2\frac{1}{4}$ in.; and its weight is 0.15 lb. Thomas A. Edison, Inc., Instrument Division, West Orange, N.J.

Tap Holder

A floating tap holder that floats the tap in and out is designed to correct parallel and angular misalignment. The construction is such that the holder permits the tap to float freely whether going in or out, and will not "freeze" under tension caused by drag of the tap. The amount of "float" is infinitely variable and is simply adjusted by means of a lock nut. There are no spring or pivot members to restrict the floating action. The tool is available with straight or tapered shank in sizes ranging from 2-in. body to $4\frac{1}{2}$-in. body for standard tabs $\frac{3}{16}$ in. to $2\frac{1}{2}$ in. inclusive. Empire Tool Company, Detroit.

Drill-Chip Breaker

An improved drill-chip breaker, which breaks the chip at each revolution of the drill, breaks chips into uniform, small pieces that are easily carried up the flutes of the drill. In operation, the short chips simply accumulate around the mouth of the hole, eliminating the long, whirling spirals that would otherwise be thrown around the machine and on the floor by the revolving drill. If the work requires coolant, it flows on the work and down the drill flutes, past the short loose chips to the point of the drill without splashing.

The Ex-Cell-O Drill-Chip Breaker can be used vertically, horizontally, or at any angle at which the housing can be kept stationary while the drill rotates. An arm is provided to prevent rotation of the housing. Where space permits, the chip breaker can be used in multiple-spindle heads.

Among the several advantages claimed for the breaker are the following: (1) Drilling is fast because it is not necessary to withdraw the drill to clear chips from the hole. (2) Drill life is unusually long because of free cutting action which results in more holes being drilled before the drill needs sharpening. (3) Holes are round, smooth, and straight because the short chips travel up the drill flutes easily without scratching the hole or forcing the drill to run out. (4) It is possible to drill holes many diameters deeper, eliminating the necessity for withdrawing the drill from the hole to relieve chips. (5) Automatic feed can be used without danger of drill breakage caused by chip-clogged holes. (6) It is safe for the operator because there are no whirling chips to burn or cut hands or fingers. (7) Operation is clean because the short chips do not splash coolant on machine or operator. Ex-Cell-O Corporation, Detroit.

Linear Potentiometers

Fairchild wire-wound linear potentiometers, a wartime development, are now available commercially for the simplification of design and production of many kinds of electrical and electronic equipment.

According to the manufacturer, the new linear series, consisting of three models, gives performance accuracies hitherto unobtainable in a single-turn potentiometer. For plotted performance, accuracies of 0.05 per cent are provided in the largest, 5-in. diameter

size, and 0.15 per cent in the smallest, 2-in. size.

In general, the life of these models is greater than 1,000,000 cycles of operation while retaining initial accuracies. All factors affecting service life which are under the manufacturer's control, such as the skill in fabricating resistance winding, contact arm, bearings, general construction, and final assembly, are given rigid attention.

The electrical angle of rotation is from 352° to 357°, leaving a maximum unwound sector of 8° in the smallest size and an unwound sector of 3° where the maximum wound length is required. These features are all combined with an unusually low torque of less than 1 in.-oz.

Potentiometers offer many possible general applications in simplifying circuit designs for precise control, when used either singly or ganged on a common shaft. Among such possible applications are communication equipment, such as aircraft and ship radio, transmitter controls for radio and television; sound-recording transcription and panel rack equipment; instrument controls and attenuators in industrial equipment, including electrical and electronic test equipment; industrial control instruments; computing and analyzing instruments; aircraft-engine controls; and others. Fairchild Camera & Instrument Corporation.

The "Flying Mailcar"

The Fairchild C-82 Packet has been equipped especially for long-range transportation of air mail, and named the "Flying Mailcar." It is capable of carrying up to seven tons of air mail. The interior of the squared fuselage has been adapted to the needs of the Post Office Department by installing such postal equipment as a sorting table, letter rack, chutes, locked drawers for registered air mail, and bag racks. The equipment, lighter than that used in railroad mailcars, is more compact and more efficient.

The Packet can handle mail loads up to six tons on a 500-mile nonstop trip, or more than four tons on a 1,200-mile nonstop flight. The plane's cargo hold, 38 ft. long, is shaped like a railroad boxcar and has approximately 93 per cent of the boxcar's cubic capacity. Double doors in the rear open to make a loading door more than 8 ft. square at truckbed height. Mail trucks can back to the door for ease and rapidity of mail loading and unloading.

All of the equipment will be specially designed of lightweight plywoods and metals. One innovation will be an oval letter case with every pigeonhole equally accessible. An intercommunicating telephone will give the mail clerk constant communication with the pilot's compartment and other sections of the plane. There is room inside the plane for one, two, or even three clerks to sort the mail en route.

Although dropping off mail to small communities is not contemplated in present plans, there is a possibility that this feature may be developed. As an Army plane, the Packet was designed for paratroop and air-borne operations. It can be easily adapted to drop cargo parachutes over airports too small for a landing. The plane can also operate from smaller runways than the usual commercial air liners, and thus serve cities that are not now on air-mail routes. Another possible development in postal service is air parcel post, which has been under discussion for some time. Fairchild Engine and Airplane Corporation.

The Army XR-9B helicopter manufactured by G & A Aircraft, Inc. The tail skid in the foreground protects the tail rotor from possible damage.

XR-9B—Army's New Helicopter

The XR-9B is one of the newest aircraft to be removed from the wartime secrecy list. In cooperation with the A.A.F. Air Technical Service Command (now called Air Matériel Command), it was developed and produced by G & A Aircraft, Inc., Willow Grove, Pa., a subsidiary of The Firestone Tire & Rubber Company and a successor to the Pitcairn autogiro organization.

The new helicopter has a 28-ft. diameter, three-blade rotor, is powered by a 135-hp. Lycoming four-cylinder air-cooled engine, and has dual controls and tricycle landing gear. Its dimensions are length, 27 ft. 7 in.; height, 8 ft. $6\frac{1}{2}$ in.; width at landing wheels, 9 ft. The main rotor is an N.A.C.A. airfoil section measuring 15.25-in. chord at the root of the blade and 8.5 in. at the tip of the blade. Rotor-blade surface area is 12.5 sq.ft. The tail rotor, also an N.A.C.A. airfoil, has a diameter of 6 ft. 6 in.; the chord measures 6 ft. $\frac{1}{2}$ in. at the root and 3.875 in. at the tip. Blade area is 1.125 sq.ft.

Rotor blades are constructed of stepped-tapered, heat-treated steel-tube spars to which $\frac{7}{32}$-in. five-ply poplar plywood ribs are attached by stainless-steel collars. Leading-edge strips are spruce over the inboard half of the blade and maple over the outboard half, having a lead ballast imbedded in them. Trailing-edge tips are made of spruce. Top and bottom surfaces of the skeleton are covered with $\frac{1}{32}$-in. three-ply mahogany with poplar core. Blades are fabric covered and "doped."

The fuselage is made of welded steel tubing with a nose section of Lucite. Fuselage fairing is aluminum alloy. The boom has a balsa core with Alclad outside skin. The instrument panel has only eight instruments.

The helicopter uses 80-octane fuel and has a maximum fuel capacity of 25 gal., enough for more than 3 hours of flying. In flight, directional heading is obtained through torque correction from the tail rotor through use of conventional rudder pedals. Horizontal travel of the craft in any direction is effected by cyclic pitch control from a conventional control stick. Vertical ascent or descent is obtained by simultaneous pitch control in connection with manual throttle to assure sufficient power and rotor r.p.m. An electric-hydraulic governor, by acting upon the simultaneous pitch control, maintains constant predetermined rotor speed, regardless of throttle condition or power used. With this arrangement, vertical control is effected entirely by use of the throttle; the governor provides automatic simultaneous pitch control in this case.

Preliminary performance data indicate that the helicopter will cruise at approximately 80 m.p.h., have a service ceiling over 10,000 ft., and a rate of climb of more than 1,000 ft. per min. Through the use of the G & A rotor-head design, vibration is said to have been virtually eliminated. The helicopter can be disassembled easily for storage or

Federated — MODERN HEADQUARTERS FOR NON-FERROUS METALS

PREPARATION—Success in modern smelting is based upon the use of scientific engineering principles. In Federated, these principles are utilized in the segregation and preparation of incoming materials. Sub-standard metals and foreign substances are eliminated and economic and metallurgical classifications are made. To accomplish this job, mechanical, electrical, chemical, spectroscopic, or colorimetric methods are used. This insures a quality product right from the start. Illustrated below is a modern installation, designed by our engineering department, used for the removal of oil, moisture, free iron, and other foreign material from aluminum borings.

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ALUMINUM • BRASS • BRONZE • BABBITT • DIE CASTING ALLOYS • SOLDER • TYPE METAL • ZINC DUST

for shipment in cargo aircraft. The tail-boom section is detached by removing six bolts and disconnecting two control wires. Rotor blades are removed by taking out three bolts and three pins and by unseating three ball-and-socket joints. The aircraft then is ready for storage or packing in three parts, consisting of the boom assembly, fuselage, and rotor blades. Two removable panels on each side of the fuselage provide easy access to the power plant and to the transmission; three additional panels are located in the boom to facilitate inspections and repair work.

Postwar modifications of the G & A helicopter have led to enlargement of the cabin and to other changes that, despite its light weight, put it in the class of the general-purpose helicopter. It is expected to be able to fly taxi service from city centers to commercial airports, refuel isolated C.A.A. airway beacons, rescue survivors from life rafts, dust crops, or fly forest patrol. G & A Aircraft, Inc., Willow Grove, Pa.

Low-Cost Lock Nut

The Gripco lock nut is a semifinished, one-piece, self-locking nut of standard dimensions which requires no lock washers or cotton pins. A wrench is all that is needed to apply or remove it. The patented triangular deflections on the top of the nut provide a controlled friction lock. The nut is free-spinning until the bolt threads make contact with the deflected threads near the top of the nut.

Extensive tests by a national testing institute are reported to have proved that the nut can be applied and reapplied many times without appreciable loss in its locking power. Grip Nut Company, Chicago.

Thrust-Measuring Device

One American type of "flying bomb," the JB-2, similar to the V-1 used to bomb London, is being tested by a new force-measuring device capable of hairline measurement of the force or thrust exerted by the new jet propulsion engines. In attempting to gage the thrust of these engines, previous measuring methods proved inadequate, according to the technical staff of the Power Plant Laboratory at Wright Field, and did not continue to give reliable indications of thrust under the severe conditions of operation. The intermittent (or pulse jet) jet engines operate in bursts at 50 cycles per sec. The vibration is extremely severe.

In testing the engine, it is securely mounted on a flexible structural-steel base. The reactive force of the engine is transmitted through a lever to the measuring device, called a Thrustorq. The force set up by the engine is read directly on a mercury column or a manometer containing a tetra-bromide-ethyl solution having the specific gravity of 3. The device is essentially an air chamber, one face of which is a flexible diaphragm. The air chamber is connected to a compressed-air line. When force is exerted on the diaphragm, a poppet valve admits air until the air pressure in the chamber exactly balances the force on the diaphragm. When this force is reduced, air is exhausted until the pressures are again in equilibrium. The response to changes in force is practically instantaneous and every normal change is followed instantly.

Although the new jet engines being tested for "buzz bomb" propulsion exert high intermittent thrusts and also heavy vibration, the device accurately receives and measures whatever force is developed. While the series of intermittent explosions is rapid and the vibration severe, the Thrustorq's diaphragm is reported to measure accurately the average thrust. Hagan Corporation, Pittsburgh.

Thermonic Flexible Leads and Coil for Induction Heating

Use of induction heating with somewhat the same degree of flexibility as the soldering iron or oxyacetylene torch is now possible by means of the flexible lead and coil setup developed recently by the Induction Heating Corporation. The heating coil is mounted on a convenient grip-type handle and is connected to a standard Thermonic output transformer by specially designed flexible leads.

By means of the flexible leads, the coil can now be brought to the work so that many bulky assemblies, which previously did not lend themselves to induction heating, can gain the advantages inherent in the use of induction-heating equipment. Suitable for both heat-treating and brazing, this new coil is being used extensively in annealing such sections as the ends of large shafts and in brazing large, tubular steel assemblies.

The heating coils used can be either single or multiturn coils although the single-turn inductors limit to some extent the amount of power which may be transferred into the work. Present indications point to the ultimate use of a split, single-turn coil of the clip-on type, which can be used for brazing continuous, closed tubular structures and piping assemblies, thus greatly speeding up the soldering and brazing of such parts.

By use of the manufacturer's output transformers, the terminal voltage of the coil is reduced to such a value as to minimize the danger of arc-over to the work and any hazard to the operator. This does away with the necessity for keeping the work precisely located within the coil and enables unskilled operators to solder or braze joints with little instruction. Induction Heating Corporation, New York.

Stencils to Simplify Making Three-Dimensional Drawings

"Instrumaster" is the brand name of a new line of drafting instruments of the stencil type, one type of which is intended for isometric drawings and the other for dimetric drawings. Each one is precision-cut from clear, high-grade plastic stock 0.040-in. gage. Graduations and lettering are engraved on the lower side.

Draftsmen may make isometric or dimetric drawings efficiently and easily by using these stencils alone without resorting to other instruments. The stencils provide inch graduations at full scale (or half scale in the case of one edge in dimetric stencils) along one vertical and two slanted edges. These three edges represent correct directions of isometric and dimetric axes.

Each stencil is provided with 27 ellipse openings correctly representing, in the individual projections, circles from $^1/_8$-in. to 2-in. diameter. Allowance is made of pencil-point or lettering-pen thickness. By placing the stencils with one edge against the straight edge, T-square, or drafting-machine blade, the graduated edges as well as the individual ellipse openings automatically assume their required positions within the drawing.

For positioning the ellipses correctly, their center lines are marked clearly by lines and small holes that always line up with the isometric or dimetric axes through the center of the ellipse to be drawn. The ellipse sizes are indicated by the size of the circle to be represented and not by their major axis, which also facilitates the draftsman's job.

Hi-Range stencils of the same type, with ellipses from $2^1/_4$ to $4^1/_2$-in. diameter also are available. Instrumaster Industries, Greenwich, Conn.

Further Data About Heat-Resisting Steel for Gas Turbines

Additional information has been made available about the British Jessop G.-18B austenitic steel, developed primarily for rotor discs, turbine blades, and nozzles for gas turbines in jet propulsion units. In addition to its use in the discs of the Rolls-Royce Derwent V engines in the Gloster Meteor, it is understood that the material is being produced for axial-flow gas-turbine rotor forgings and for discs approaching 3 ft. in diameter. A typical composition of the steel, in percentages, is as follows: carbon, 0.4; manganese, 0.8; silicon, 1.0; nickel, 13.0; chromium, 13.0; cobalt, 10.0; tungsten, 2.5; molybdenum, 2.0; columbium and tantalum, 3.0.

The heat-treatment conditions that have been found necessary in widely separate applications of this material are known respectively as (a) solution-treated; (b) solution-treated and aged; and (c) solution-treated and warm-worked, to achieve highest values of proof stress and creep properties at temperatures ranging between 1,300° and 1,500°F.

It is stated that successful solid disc forgings of this steel have been made in diameters up to 32 in. with a maximum boss thickness of $5^1/_4$ in., and it is believed that the thickness can be increased up to 7 in. if required. The manufacturers, William Jessop & Sons, Limited, of Sheffield, England, state that there is no reasonable limitation on the length of shaft that can be produced by this method, except the current facilities for obtaining a particular heat-treatment. The firm has also successfully fabricated G.18B turbine discs,

flash-butt-welded to aeronautical-quality standards, to a lower-carbon stainless shaft material having columbium additions and designated as their special R.20 austenitic steel. This welding technique has permitted certain special problems to be overcome, especially in gas turbine or jet propulsion units where more than one rotor disc is employed and longer shafts are involved.

The manufacturer is prepared to consider the production of solid rotor forgings in G.18B steel having drum sizes up to 18 in. in diameter, with an axial length of 3 ft. and with integral extension shafts giving an overall length up to 7 ft. In the case of these larger components the heat-treatment has been especially developed for these forgings and results in creep tests are stated to be within 15 per cent of the high creep properties claimed for smaller pieces under precise laboratory control.

This material is reported to have hot fatigue strengths, for an endurance limit of 40,000,000 reversals, ranging from ±40,300 lbs. per sq.in. at 1,112°F. to ±29,200 lbs. per sq.in. at 1,292°F. These values refer to the steel in the solution-treated condition referred to in (a) above. The 0.1 per cent proof figures at room temperatures for G.18B steel range between 31,000 and 58,000 lbs. per sq.in., according to the heat-treatment. William Jessop & Sons, Inc., New York.

Two-Band Radio for Light Planes

Following the announcement of the first Lear PX'er single-band aircraft radio model several months ago, the manufacturer has introduced a two-band PX'er, Model TR-2B. The two bands cover the entire beacon and commercial broadcast frequencies, permitting complete two-way communication, navigational aid on radio ranges, entertainment programs, and direction finding when tuned to standard broadcast stations. The new model offers the private pilot a low-cost, lightweight radio that can be installed in the smallest airplane to provide dependable service in cross-country flying.

The complete set, including transmitter-receiver, power supply, headphones and microphones, weighs only 10 lbs. It is divided into two units, with the control unit mounted directly on the instrument panel, and the power-supply unit remotely located in the airplane. The transmitter consists of a crystal-controlled oscillator, power amplifier, and modulator, and has an output of approximately twelve watts. The receiver has a superheterodyne circuit with a stage of radio-frequency amplification.

The component parts of the Model TR-2B have been specially designed to withstand humidity, temperature, and vibration tests, and are rated at a safe margin above maximum load conditions and breakdown voltages. The plate and screen voltages are supplied by a dynamotor with sufficient filtering to insure proper voltages. Tube filaments and excitation relay voltage are directly supplied by a twelve-volt battery. The receiver has adequate power output to operate at loudspeaker level when required. It also has an antenna sensitivity of 5 microvolts per meter or better on Band One with a 4-to-1 noise ratio at 50 milliwatts output. On Band Two, the receiver has an antenna sensitivity of 5–10 microvolts per meter with a 4-to-1 noise ratio. When used as an aural-null direction finder, employing a loop, sensitivity is about 50–80 microvolts. Lear, Inc., Grand Rapids, Mich.

Flux-Coated Bronze Welding Rod

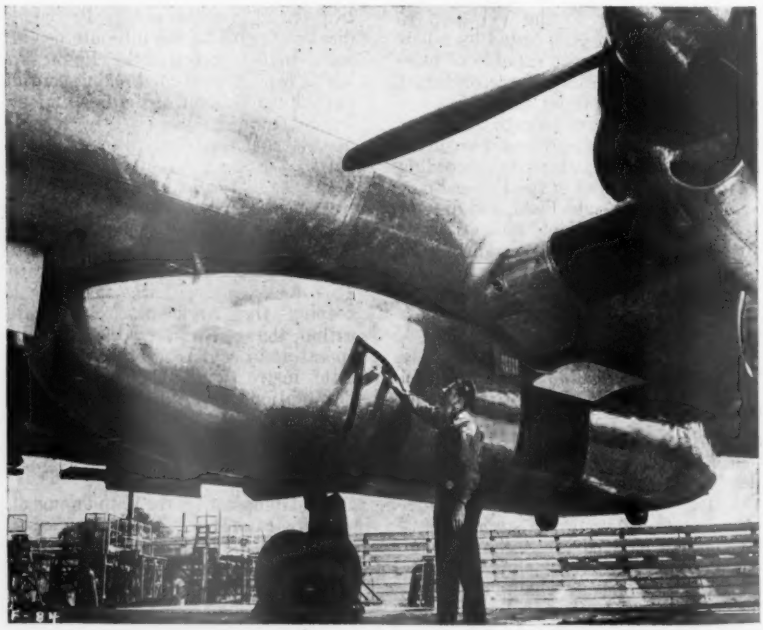
A new flux-coated bronze welding rod for application by the oxyacetylene process is known as Oxweld No. 25M flux-coated rod. When the rod is made, it is precoated with flux in proper proportion to its size. This coating consists of Brazo Flux plus a nonactive binder that does not affect the weld. It adheres firmly to the rod, melting down into the molten puddle without burning off ahead of the rod. The rod can be heated and bent without destroying the coating. In addition, the coating is not affected by weather conditions.

The maker states that No. 25M Flux-Coated bronze rod speeds up the welding operation and makes it easier to produce welds of uniformly high quality. The operator can give his entire attention to depositing the rod metal and controlling the molten puddle without the usual delays of dipping the end of the hot rod into the flux container. The flux melts into the weld continuously and in the right quantities, leaving no wasteful residue on the face of the weld. Thorough tinning, essential to good bronze-welding, continues without interruption. The Linde Air Products Company, Unit of Union Carbide and Carbon Corporation.

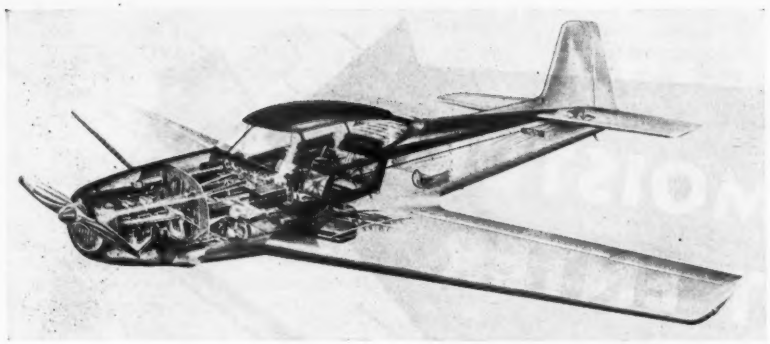
External Cargo Container Increases Constellation Pay Load

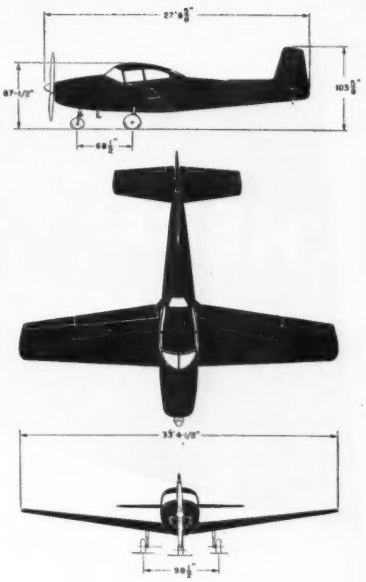
An increase of four tons in pay load of the four-engined Lockheed Constellation for flights up to 1,500 miles has resulted from development of the Speedpak, an all-metal streamlined cargo container that fits snugly to the underside of the fuselage. It gives air-line operators the equivalent of two airplanes in one—without the Speedpak, a swift, long-range transport with ample fuel for extensive nonstop operation; with the Speedpak, a heavy-duty, high pay-load transport with additional cargo and mail loads to take advantage of otherwise unused weight-carrying capacity on short-route operations. Conversion from one type of service to the other takes 2 min., the amount of time needed to remove or attach the device. An important feature of the device is the ease with which ground attendants can load and unload passenger baggage. A built-in electric hoist lowers the Speedpak rapidly to convenient loading height and as quickly raises it into position to be locked for flight. Using the container, attendants can load baggage prior to flight time inside terminals. Special removable compartments can be designed for intermediate points, to be removed and replaced as a unit, or the container can be loaded as a whole.

Development work began on the Speedpak when Constellation performance tests demonstrated the ability of the airplane to maintain its high safety factor and fast speeds at gross weights considerably exceeding those for which it was designed. This meant that more pay load could be added but the problem consisted in finding space for it. The airplane's lines left no unused space for either passengers or cargo in



The Lockheed Constellation ready for take-off with a loaded Speedpak firmly attached to its fuselage.





A phantom view and three-view drawing of the new North American Aviation, Inc., Navion.

the standard fuselage. But since the P-38 Lightning fighter had been able to take on numerous external fittings for which it was never intended, with no bad aerodynamic effects, it was decided to try the same idea with the Constellation.

The container, attached to the bottom of the fuselage between the wings, is 33 ft. long, 7 ft. wide, and 3 ft. deep. Its total volume is 395 cu.ft. Weight empty is 1,700 lbs. With a maximum cargo load the gross weight of the container and its contents amounts to 10,000 lbs. The builder conducted extensive wind-tunnel tests of various external cargo carriers before developing the present version, which is reported to have no adverse effect upon flight characteristics of the airplane.

Present Constellation baggage space, amounting to 440 cu.ft. below the floors, still will be used. As in most airplanes, this space must be reached from ladders or elevated platforms. For flights with the Speedpak, cargo, mail, and express not requiring frequent rearrangement will be carried in this space. Lockheed Aircraft Corporation.

Metal Propeller for Light Plane

The Met-L-Prop propeller, forged from aluminum, is now available to owners of light, personal planes. This new thin-sectioned metal propeller is expected to have a long service life. The manufacturers state that preliminary tests demonstrated the following advantages: (1) take-off run is shortened; (2) the rate of climb is increased; (3) a faster cruising speed can be achieved without sacrificing take-off performance.

The elimination of maintenance expense is another feature claimed for the propeller. It is corrosion resistant, it cannot swell, crack, or warp, and weather elements have no effect. The maker's years of experience in the manufacture of steel propellers contributed to the development of the new product. The McCauley Corporation, Dayton, Ohio.

Flux for Brazing Aluminum

Flo-Well No. 2 is a new flux that is reported to be useful with X716 wire in either furnace brazing or torch brazing of aluminum. It can be applied easily by inexperienced workmen and will not solidify or deteriorate. The flux and the wire may be employed alone in brazing 61S and, in combination with hydrogen and oxygen, may be used in brazing 2S, 3S, 24S, and 52S. The X716 wire can be obtained wherever aluminum is sold. The new flux is packaged in $\frac{1}{2}$-lb. and 1-lb. glass jars for protection from moisture, and is also available in larger quantities. A. K. Mauk, Pittsburgh.

Versatile All-Metal Personal Airplane

North American Aviation, Inc., has entered the personal-airplane field with the "Navion," an all-metal, four-passenger airplane designed for the postwar civilian pilot. It is a low-wing, side-by-side, dual-control airplane featuring flight characteristics and economy of operation to meet the combined demands of pleasure, sport, or business flying.

Powered by an air-cooled Continental 185-hp. engine, the plane has an estimated cruising speed of 150 m.p.h., a top speed of about 160 m.p.h., and an estimated maximum range of 700 miles.

It features a new and specially designed wing that is stated to give the plane unusual aileron control at low speeds when approaching the stall. The root sections of the wing are the first to stall, eliminating tendency of the airplane to roll, and maintaining good aileron control up to and through the stall. The curvature of the wing-tip section further reduces any tendency for the tip sections of the wing to stall first. Through this design, North American engineers achieved a smooth and gradual flow of air over the wing-tip section, avoiding an abrupt "bend." The craft has a power-retractable tricycle landing gear with a 20° steerable nose wheel for easy handling on the ground. The tricycle gear and full-vision canopy contribute to ease of handling for taxiing, take-offs, and landings.

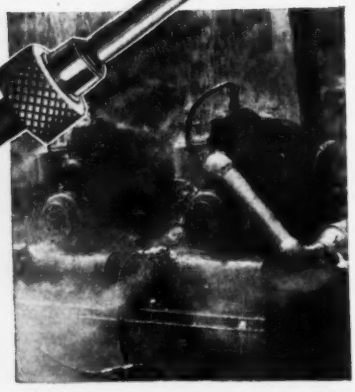
Careful consideration was given to design of the interior to provide comfort and luxury for four passengers. The ventilated enclosure under the sliding canopy is 43 in. wide and has the appointments of a luxurious automobile interior. The individual front seats are adjustable and the back seat may be removed to accommodate 435 lbs. of luggage in 46 cu.ft. of space. Access to the luggage compartment back of the rear seat is from the cabin interior. The passenger enclosure is the widest part of the semimonocoque fuselage, which is constructed as a single unit.

The elevator and horizontal stabilizer assemblies are interchangeable, left and right, and the rudder has a trim tab adjustable on the ground. All hinge points contain ball bearings and all surfaces can be easily removed. The monocoque engine mount is structurally part of the fuselage, eliminating the conventional steel tubular design. Any part of the six-cylinder engine can be easily reached for inspection or repair. The standard model is equipped with a Delco-Remy electric starter, navigation lights, flight and engine instruments for contact flying, and variable-pitch propeller.

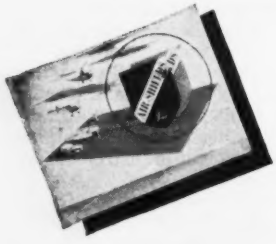
The surface-control system is of the pulley and cable type, with dual wheel and pedal controls for the pilot and copilot. The copilot's controls can be easily and quickly removed so that the right front seat can accommodate a non-pilot passenger. The rubber-mounted instrument panel is designed so that the basic instrument arrangement will not be radically altered when additional instruments for night or instrument flying are installed.

The Navion has a wing span of 33 ft. 5 in.; length, 27 ft.; height, 9 ft.; and weighs 1,551 lbs. empty. Carrying a useful load of 1,019 lbs., the plane will fly at a gross weight of 2,570 lbs. In addition to the passenger and luggage weight, the useful load includes 10 qts. of oil and 40 gal. of gasoline in the two 20-gal. pressed-steel wing tanks.

Fully loaded, the airplane will take off in a 695-ft. ground run and climb at approximately 830 ft. per min. The



The Spray Test given to Air-Shields Shielded Leads to prove their waterproofness under most adverse conditions.



Send for this book. It tells you why Air-Shields seamless tubular shielded leads are far superior to ordinary shielding.

The problem of moisture seeping into engine ignition harnesses has been completely solved by the use of Air-Shields seamless tubular shielded leads.

Air-Shields harnesses not only prevent the entrance of moisture from outside, and the occurrence of condensation within—they combine these 6 exclusive, vitally important features: 1) Ignition system emanations are prevented from interfering with radio communications and other electronic devices; 2) An Air-Shields installation weighs from 50 to 70 percent LESS than flexible hose-type shielding, yet will stand up to 60 pounds of air pressure at the joints. This combination of light weight and great fatigue strength saves hundreds of dollars per pound every month in airplanes, 3) There is no space for formation of corona and its destructive effects on insulation of cable; 4) Vibration is isolated and controlled; 5) Possibility of metal crystallization and failure is effectively reduced; 6) In most cases, the initial cost of Air-Shields leads is below ordinary shielding.

Intensive, gruelling tests, in the laboratory and under actual conditions of use, have definitely proved that Air-Shields seamless tubular shielded leads are clearly superior to ordinary shielding—that they do a far better job in airplane, automobile, marine and stationary gas engines.

If you have a shielding problem, call on Air-Shields engineering staff for expert help.

"It seems obvious, and in fact is true, that for the same weight and type of metal a seamless metallic tube has greater shielding effectiveness than an all-braid tube."—A leading Air Corps technician, Aircraft Radio Laboratory, in *Aeronautical Engineering Review.*

AIR-SHIELDS *Inc...*

Manufacturers of seamless tubular shielded leads, shielded spark plugs, ceramic terminal contacts and components

Hatboro, Pennsylvania

stalling speed is approximately 53 m.p.h. and the service ceiling approximately 15,600 ft. Landing at approximately 54 m.p.h. with 40° flaps, the plane will use a 605-ft. ground run.

Designed and constructed for practical use in all types of personal flying, the interior offers possibilities for a wide and diversified use of the airplane. Through removal of the rear seat and the right front seat, additional space is obtained for the use of farmers, salesmen, or sportsmen who wish to utilize most of the space for heavy and bulky loads. The luggage compartment can be converted to carry photographic equipment for aerial surveys, or other special equipment. North American Aviation, Inc.

Improved Wet Belt Surfacer

An improved wet belt surfacer, Model BG-8, surfaces, grinds, and removes stock by means of an abrasive belt. The surfacer offers high production, close tolerance performance, and superior finish. It is claimed to eliminate warpage, discoloration, and burrs when used in tool and die rooms, large production plants, and in machine shops.

The new model is equipped with a large-capacity recirculating tank for longer operational performance. The coolant, applied to work and belt by a spray nozzle, maintains the work in constantly cool condition and prevents weakening of the structure of certain kinds of materials, such as plastics, rubber, ceramics, glass, and tempered metals.

The depth of the machine has been reduced from 62½ in. to 48 in. to conserve space. The worktable of the new machine measures 38 in. from the floor in contrast to the previous distance of 40½ in.

The automatic feedtable is designed to give a tolerance accuracy of 0.0005 in., it controls the in-feed pressure and speed, reduces operator fatigue by substituting mechanical pressure for hand pressure, and frees the operator during the operation to prepare for the next production cycle.

A flat, hardened steel platen is used to back the belt during the grinding operation. Platens of standard size are 9 in. by 12 in. The working area of the standard table is 17½ in. by 11¼ in. An abrasive belt 8 in. or 9 in. wide by 107 in. in circumference can be used. Resilient platens can be used on the new model BG-8. Such platens are used when the surface to be ground need not be perfectly flat or parallel with other surfaces. They are also used when surfacing or grinding concave or convex surfaces. Porter-Cable Machine Company, Syracuse, N.Y.

All-Metal Personal Plane

Preliminary specifications and description of a new four-place, pusher-type, all-metal monoplane, known as the Wheelair 111-A, have been released. Having a maximum speed of 135 m.p.h., a cruising speed of 120 m.p.h. at 75 per cent power, a landing speed of 55 m.p.h., and normal cruising range of 600 miles, this new airplane features automobile-type, fully upholstered seats, with provision for pilot, three passengers, and 160 lbs. of baggage. Adjustable front seats allow a change of position for pilot and passengers. Both front and rear "coach-type" seats are divided so that each can fold forward independently of the other. The front seats hinge to allow easy access to the rear passenger seats. The rear seats fold forward to gain access, even in flight, to the luggage compartment.

The pusher design and forward-placed cabin are stated to give good vision range. The twin tail booms provide protection from the propeller for passengers and onlookers while on the ground. The airplane may be safely loaded or unloaded without stopping the engine.

A Lycoming GO-290-AP four-cylinder air-cooled engine is to be used as standard equipment. A geared, horizontally opposed engine, it develops 170 hp. for take-off, and has a normal rating of 160 hp. Gross weight of the airplane is 2,500 lbs.; weight empty is 1,350 lbs. The wing loading is 13.9 lbs. per sq.ft.

The fixed tricycle landing gear has been chosen because of simplicity of design and weight considerations. The nose wheel is steerable to facilitate landing and parking. The cabin interior will be styled in rich fabrics with a compact grouping of all engine and flight instruments. A large parcel compartment for the storage of charts, purses, and comparable items is located in the instrument panel. A compartment is provided for two-way radio, if the buyer wishes this added accessory.

A battery, with engine-driven generator, provides power for starter, landing and navigation lights, and radio equipment. Fuel tanks are located in the wing stubs away from the engine, and have a 50-gal. total capacity. The oil tank and filler cap are reached through the hinged service panels that cover the engine compartment. The Wheelair 111-A has an overall length of 26.62 ft., and a wing span of 37 ft. Overall height is 7.12 ft. Puget Pacific Planes, Inc., Tacoma, Wash.

Radio Transmitter for Aircraft Communication

The high power and multifrequency operation required of an aircraft radio transmitter to meet the conditions imposed by the increased cruising range and speed of modern aircraft are said to be features of a new lightweight transmitter, the RCA Model AVT-49. This new four-channel transmitter, weighing only slightly more than 40 lbs., is capable of supplying 50 watts of output power. A simple band-change mechanism makes possible instant selection of any one of the four pretuned frequencies by the turn of a switch.

The AVT-49 transmitter is the first unit in a new RCA line of matched equipment especially designed for executive planes, aerial taxi operators, cargo planes, "bush" fliers, feeder air lines, sportsman pilots, and foreign air-line service. The transmitter and its dynamotor power supply are completely contained in one shock-mounted metal cabinet. The only additional unit is a master remote-control box, which may be located anywhere within the 15-ft. reach of the control cable from the transmitter. This arrangement simplifies the placement of both units in the most suitable locations with respect to aircraft design and the convenience of the operator.

The four frequencies available within a range of 3 to 13 megacycles enable the pilot to make contact with C.A.A. stations and airport control stations while in flight, on the ground, or while taxiing. It is possible to operate the unit on a frequency as low as 2.85 megacycles, if desired, by the addition of a capacitor. Once tuned, the band change is accomplished through switch operation of the band-change mechanism, employing a ratchet motor. Manual operation is provided for initial tune-up or local control. The multifrequency operation facilitates reliable communication by permitting selection of the most usable frequency to avoid atmospheric disturbances and to take advantage of skip distances. Frequencies may be selected to provide communication with stations on the routes most frequently flown, as well as for foreign flights and special services. Provision is made to accommodate four RCA Model AVA-67 crystal units or two Model AVA-21 air-line type dual crystal units. Crystal units AVA-10, AVA-11, and AVA-53 also may be used, as well as the standard 3-pin air-line-type holder. Crystals may be used for fundamental or second harmonic operation.

A built-in universal antenna-loading system is intended to assure tuning with any normal aircraft antenna, either fixed or trailing, without additional external loading coils. Losses are kept at a minimum by the use of ceramic coil forms and switch wafers. The antenna coils are wound with sterling-silver wire. Instead of fuses, the new transmitter has a manual reset type of thermal circuit breaker mounted on the front panel. This component is interchangeable with the automatic reset type of circuit breaker, should the latter be preferred. A d.c. milliameter is mounted on the front panel of the transmitter for complete metering of all circuits necessary for tuning. This meter may be removed from the transmitter panel and installed at a point convenient to the pilot or as an aid in tuning a trailing wire antenna. An aluminum plate is provided to close the opening in the transmitter panel if this change is made.

Designed for either 12- or 24-volt operation, the transmitter does not require rebuilding if transferred from one plane to another with a different voltage supply. Conversion from 12 to 24 volts can be made in 15 min., involving only changes of the dynamotor, circuit breaker, and control-box pilot lamp. Bus jumpers are provided on easily accessible terminal boards for other necessary circuit-modifications. Dual voltage relays are used. Case dimensions of the AVT-49 conform to ATR specifica-

tions for air-line rack mounting and a separate shock mount is available for individual mounting. Radio Corporation of America, RCA Victor Division.

Small Welding Unit

Electronically controlled welding with all its advantages is made available in the low-price field by means of the Raytheon Miniature Weld Power equipment. It lessens the necessity for the human element of control of the quality of the weld. Production by unskilled help is greatly increased, with more uniform results.

The unit is small, measuring 9¾ in. high, 13 in. wide, and 13½ in. long, and is capable of producing 60 to 120 welds per min. on a total thickness of 0.035 in. for practically all metals and principal alloys, or combined pieces being welded of 0.060 in. to 0.070 in. in cross-wire welding. The instrument need only be plugged into the most convenient source of 110–125 volt, 60-cycle output. Current drain averages only 3 amp. at maximum setting.

The power output into the weld can be varied. A voltage-adjustment control varying the capacitor charging voltage from 750 to 1,500 volts, and a three-position capacitor switch by which values of 14, 28, or 56 microfarads can be attained, are mounted on the front panel of the control unit.

After having once been adjusted for a given power and time cycle for certain material and thickness, the unit requires no further adjustment to produce constant, uniform welds. The materials to be welded are placed between the electrodes and the energy stored in the electric storage system is applied to the pieces to produce a weld.

The welding head supplied with this unit is designed to give a preset pressure to the material being welded and, as soon as the pressure is applied, the power is triggered by a microswitch mechanism located in the head, thereby controlling the applied pressure and cycling of the weld power.

Metals that may be welded by the machine include iron, aluminum, copper and copper alloys, nickel flat and wire, nickel alloys, tantalum, platinum sheet or wire, tungsten sheet or wire, gold sheet or wire, constantan sheet or wire, stainless steel, and alloys of the above materials. Raytheon Manufacturing Company, New York.

Adjustable Fixtures for Gaging Instruments

New standard adjustable "Airsnap" fixtures for use with Precisionaire instruments provide flexibility in checking external dimensions by airflow, and are available in eight models covering a range of from 0.250 in. to 2.000 in., inclusive. Larger sizes may be had on special order. The maximum diameter of the part to be checked determines the size range and model. Standard adjustable Airsnaps can be used with Sheffield Precisionaires on dimensions with tolerances ranging downward from 0.0002 in. Special adjustable Airsnaps may be used for checking to tolerances of 0.0002 in. down to ten-millionths or less.

The adjustable anvil may be located at any point within a ¼-in. range. It is mounted so that its gaging surface is always parallel to that of the fixed anvil. The backstop is adjustable along an angular way so that when in contact with the extensions of the adjustable anvil it is square with the anvil gaging surfaces and in proper position automatically to line up the axis of the part with the center of the two air jets. The oversize setting enables the utilization of the full manufacturing tolerance of the part in gaging and allows the proper amount of air to flow so as to obtain a correct reading. Because of tungsten carbide surfaces, wear on the gaging anvils is reduced to a minimum. Each adjustable Airsnap has built-in balanced airflow accuracy so the reading does not change if one anvil is closer to the part than the other.

The adjustable Airsnap, used with the Sheffield Precisionaire, has a wide range of applications for checking external dimensions of work in or at the machine or at the bench. It is also used on work that is too large or unwieldy to be presented to the gage and for checking close to a shoulder. Highly finished or soft-plated parts can be checked with the minimum possibility of marring or scratching, and thin-walled cylinders can be checked on the outside diameter without danger of collapsing. The Sheffield Corporation, Dayton, Ohio.

Great Britain's Largest Landplane Air Liner

Flight testing has been started for the prototype of the Avro Tudor II, said to be the largest landplane air liner yet built in the United Kingdom. As a 60-passenger air liner, the airplane has a range of 1,850 miles, flying at 230 m.p.h., at a height of 20,000 ft. With a 40-seat day installation (convertible to a 22-berth plan), it has a range of 2,450 miles at 230 m.p.h. at 20,000 ft. As a freighter, it has room for nine tons of cargo, which can be carried for 1,100 miles at 200 m.p.h. at 10,000 ft. By filling two extra tanks in the wings, the fuel load can be increased to 3,300 gal., to give a maximum range of 4,100 miles.

Its propellers are driven by four Rolls-Royce Merlin engines rated at 1,770 hp. each. At cruising power, the four engines give a speed of between 200 and 250 m.p.h. At full power, they increase the speed to 325 m.p.h. With only three engines working the plane can climb to a height of 23,400 ft. Although it weighs some 34 tons, the Tudor II is air borne after a run of only 880 yds.

From tip to tip, its wing span is 120 ft.; from nose to tail it measures 105 ft. 7 in.; and on the ground it stands 24 ft. 3 in. high. Its 11-ft. diameter cabin has 4,020 cu.ft. of space entirely free from internal obstructions, thus making possible a wide variety of interior layouts. The Society of British Aircraft Constructors, Ltd.

Miniature Hydraulic Control

A miniature hydraulic remote control, said to be the smallest of its type and weight yet offered to the aircraft market, has been developed by Sperry Products, Inc., manufacturers of larger units in the same field. Numerous applications are possible but those most frequently used are for throttle, mixture, governor, and all sorts of position-indicator controls.

The new product retains all the advantages of the previous larger units in that only a single flexible copper tube is used, the system is completely enclosed, and the installation is easily accomplished with but three small bolts for each of the two pieces that make up the complete unit.

Transmitter and receiver, made of bronze, together weigh only 3.7 lbs. Any motion of the transmitter arm will be duplicated by the receiver arm. Either arm will move through an arc of 60°, and the receiver arm may be drilled at any location to obtain the desired linear travel of the actuating rod.

The complete system is dustproof and waterproof. Transmitter and receiver may be joined by as much as 35 ft. of connecting tubing without experiencing any difficulty, and lengths even longer than that may be used where conditions of temperature and load will warrant it. Sperry Products, Inc., Hoboken, N.J.

Decimal-Scale Gages for Fine-Tolerance Checking

For fine-tolerance checking the Decimatic series of indicators are characterized by dial markings in decimals, directly comparable to blueprint tolerances. Important mechanical and practical features also are presented.

Working advantages include the modified range of about 240° on the dial. This range, while adequate for all but coarse tolerance checking, eliminates the possibility of failure to notice a complete revolution of the hand.

Mounting dimensions are in accordance with American Gage Design Standards and consequently Decimatic models may be used in fixtures made to receive AGD indicators. The indicators depart from AGD specifications only in range and in the manner of marking the dial.

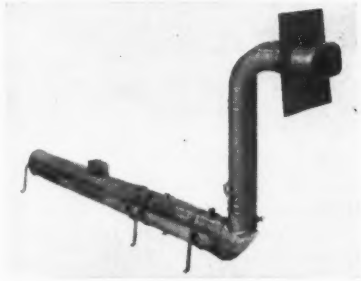
The series of indicators comprise 19 different models with a variety of graduation values in both English and metric units. Standard Gage Company, Inc., Poughkeepsie, N.Y.

Heater Kit Adaptable to Cessna Airplane

Installations are being made of complete Janitrol aircraft-heater kits designed for the Cessna UC-78 and also basically suited for other small and medium-sized airplanes. The system is built around the 15,000 B.t.u. Janitrol aircraft heater of the same type which has been used in the North American Mustang and many other fighter and carrier-based airplanes, according to

the manufacturer. The other parts in the kit include a ram air scoop, air ducts and diffuser, thermal switch assembly, stress-skin fittings, fuel controls, switches and necessary nuts, bolts, screws, and brackets. The new heating "package" may be modified to supply the heat requirements in the coldest weather for small to medium-sized airplanes with cruising range of from 100 to 180 m.p.h.

The complete kit obviates the necessity for local fabrication of parts and fittings by providing all necessary components and parts including nuts, bolts, screws, and brackets for complete installation. Stress-skin fittings also are supplied for the point where the heater exhaust-gas pipe passes overboard. The manufacturer reports that time for installation runs between 4 and 8 hours. Test data and installation instructions are available from the manufacturer.



A Janitrol aircraft heater for installation in small and medium-sized airplanes. The heater shown is 17 in. long, is 4 3/4 in. in diameter, and weighs approximately 6 lbs. The diffuser at left is connected to the heater.

The heater operates on liquid fuel taken from the engine fuel-supply system. In a typical Cessna installation, warmed air is directed across the cabin floor by the louvered air outlets in the heated-air diffuser that extends from the combustion heater. The heater and diffuser are installed on the cabin floor behind the front seats. The system is protected from excessive air outlet temperatures by the thermal switch assembly, which is located in the heated-air diffuser near the outlet. It also turns off the combustion heater igniter coil after ignition takes place. Current for operating the igniter and fuel-control valve is obtained by a connection with the airplane's electrical system.

Summer cabin ventilation is obtained by circulating unheated ram air through the system in controllable quantities. Both combustion air and ventilating air are obtained from the ram air scoop, which is designed so that there is no connection between the two sections.

This Janitrol heater kit is the same in principle as the aircraft heater packages the company is making for the manufacturers and operators of modern commercial air liners, such as the Douglas DC-6 and DC-4, Lockheed Constellation, Curtiss-Wright Commando, the Army's C-54 returned to commercial service, and several others. Surface Combustion Corporation, Toledo, Ohio.

All-Purpose Aircraft Grease

Development of a new general-purpose aircraft grease that provides satisfactory lubrication between temperature extremes of −40°F. and 250°F. is announced by The Texas Company. Known as Regal Starfak Special, it conforms to Army-Navy Aeronautical Specification AN-G-15.

It is designed for general lubrication of military and commercial aircraft in such widely varied applications as landing gears, wheel bearings, control bearings, propeller hubs, magneto and generator bearings, and gears. To meet the requirements of a general purpose aircraft grease, it was subjected to an unusually rigid set of performance tests, including a long-service test to determine its retention of original lubricating value at both low and high temperatures; practical tests to evaluate resistance to water washing and oxidation; and extremely stringent tests to determine the extent of structure breakdown or consistency change when subjected to shear or repeated workings.

The grease easily passes the test requiring that it lubricate satisfactorily a Conrad 204K ball bearing when operated at 10,000 r.p.m. and 250°F. for 1,000 hours. In this test the grease retained its original lubricating values for over 1,800 hours. The grease was worked in the A.S.T.M. mechanical worker using a plate containing 325 holes, 1/16 in. in diameter, at the rate of 60 double strokes per min. for 100,000 strokes, contrasting sharply with the total previously required of 60 strokes. Although a softening to 375 A.S.T.M. penetration after this test is permitted, Regal Starfak Special showed a penetration of only 288, representing practically no softening. The Texas Company.

Shielding Conduit Has Molded-on Jacket

An improved shielding conduit called Fleximold combines increased radio-shielding efficiency with the ability to withstand mechanical wear. Radio shielding is achieved by using a Titeflex flexible, all-metal inner core with a specially developed metallic outer braid. By molding a synthetic-rubber jacket over this outer braid, the conduit is made more rugged.

The molded-on jacket reduces chafing and wear of the conduit braid from engine parts and clamps. Acting as a dampener of vibration, it increases fatigue resistance. Other characteristics are its resistance to disintegrating attacks of lubricants, gasoline, and anti-icing fluids, and ability to maintain its functions under the low and high temperatures encountered in actual operating conditions. Titeflex, Inc., Newark, N.J.

Helicopter for Private Use

The "Commuter" helicopter, designed by Stanley Hiller, Jr., is intended primarily for the private-owner market and will be priced at approximately the same figure as an airplane of equal horsepower. The Hiller control system, which provides control of lift, hovering, descent, and movement of the craft in any direction, is a primary feature of the craft and is claimed to give a simplified technique of helicopter control for persons with limited flying experience.

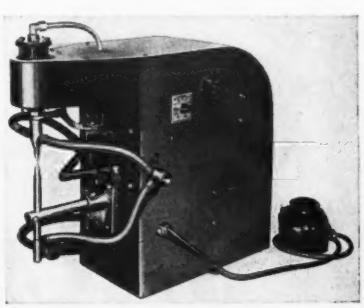
The rotary wings consist of two sets of counterrotating blades, driven by the air-cooled engine which is located behind the passenger compartment. A free-wheeling clutch permits autorotation of the blades and a controlled descent without the use of power. Conventional "stick" and "rudder" pedals are used to direct the movement of the helicopter, and a combination throttle and pitch-control varies the vertical and horizontal speed. Since the counterrotating blades neutralize the torque effects, the helicopter does not require a tail rotor to stabilize the craft.

The helicopter has a gross weight of 1,600 lbs. and a weight empty of 1,080 lbs. Behind the passenger's seat is a baggage compartment. Rate of climb vertically is 1,650 ft. per min., and a cruising speed up to 100 m.p.h. can be attained. The service ceiling is above 10,000 ft. The frame of the craft is made of welded steel tubing with a formed metal fuselage of tear-drop shape. The forward section is of formed plastic material that provides adequate vision range. A removable metal cone forms the tail portion of the craft and encloses the engine. When removed, the entire power plant and control mechanism is exposed. The rotor blades feature a tubular spar with a smooth, unbroken dural-sheet skin. United Helicopters, Inc., Berkeley, Calif.

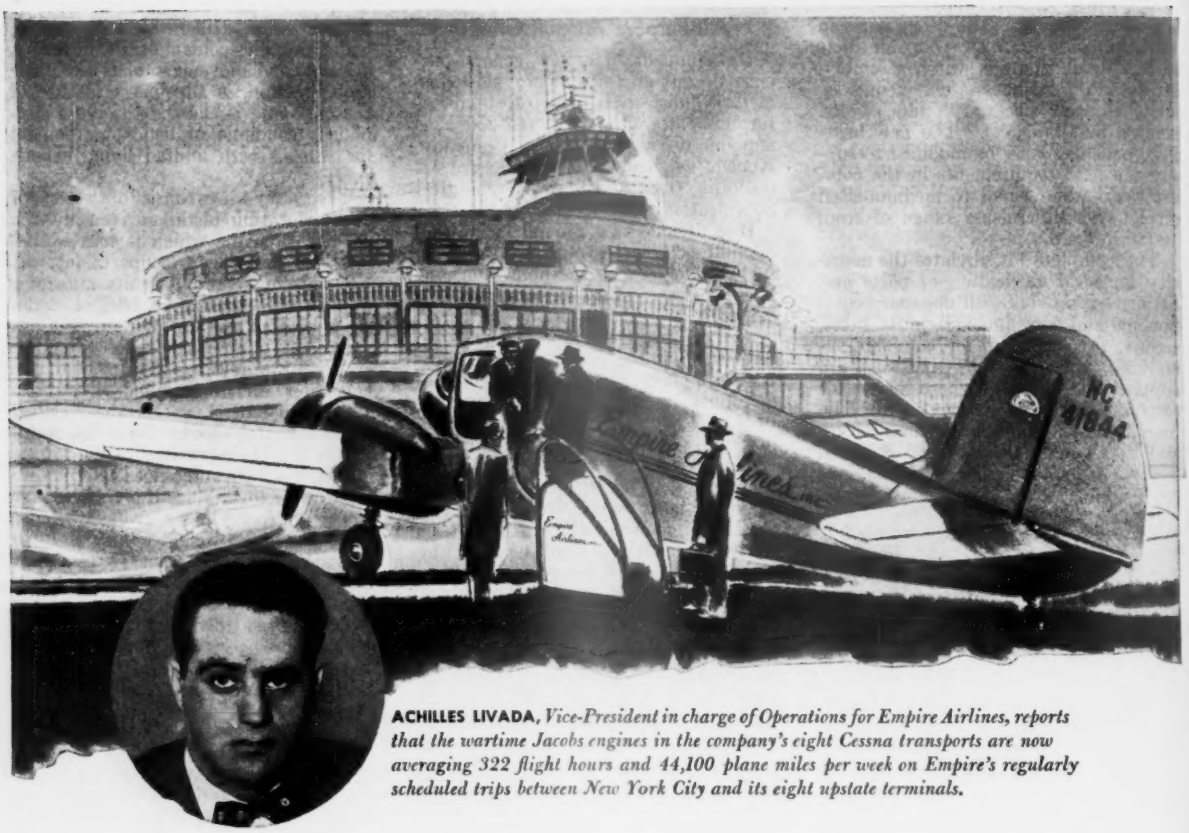
Improved Bench-Type Spot Welder

A recently improved bench-type spot welder, the Weldex Model 263-A, is a 3-kva., 220-volt, 60-cycle, single-phase precision welder. It is air operated, foot controlled, electronically timed, with an adjustable pressure switch, and is recommended by the maker for spot welding of lightweight metals, up to 18 gage C.R.S. or equivalent.

The machine measures 21 in. high, 10 in. wide, and 23 in. deep, has a new streamlined body and air-dry enamel finish, and weighs approximately 135 lbs. when ready to ship. Additional models of Weldex Welders are being developed and will soon be announced. Weldex, Inc., Detroit.



The Weldex, Inc., bench-type spot-welder.



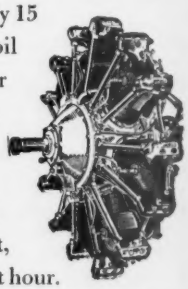
ACHILLES LIVADA, *Vice-President in charge of Operations for Empire Airlines, reports that the wartime Jacobs engines in the company's eight Cessna transports are now averaging 322 flight hours and 44,100 plane miles per week on Empire's regularly scheduled trips between New York City and its eight upstate terminals.*

Wartime engines . . . on a peacetime job—

Empire Airlines began operations on December 26, 1945, at LaGuardia Field . . . and within three months was flying twenty-six daily schedules which bring fast air service within convenient reach of thirty-two communities in the Empire State. These flights are maintained with newly converted AAF UC-78 Cessna transports powered by the wartime Jacobs R755-9 engines.

On peacetime airways, the Jacobs is again demonstrating the performance that established unsurpassed records for continuous service and minimum maintenance among engines used by the Army Air Forces . . . is carrying peacetime payloads for scores of the new airlines and charter services, for hundreds of new private owners. The stamina, dependability and low operating costs which have characterized the Jacobs in the past, are confirmed once more in today's commercial operation.

And the Jacobs R-755A, a new and improved version of the wartime R755-9, has been benefited by quantity production experience, better metals, extensive research . . . With the same dry weight, 510 lbs.—the new model has a normal rating of 300 hp at 2200 rpm . . . uses only 15 gallons of fuel and 1 quart of oil per hour, cruising at 70% power . . . is the most efficient, non-supercharged radial engine in its power class available today . . . will fly more miles or greater loads at lower cost, with high security in every flight hour.



The R-755A is available for immediate delivery. Inquiries are invited . . . Jacobs Aircraft Engine Company, Division of Republic Industries, Inc.

JACOBS • **Pottstown, Pa.**

Division of Republic Industries, Inc.